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Compressed Air Magazine

Vol. XXXII, No. II London New York Paris 35 Cents a Copy

FEBRUARY, 1927

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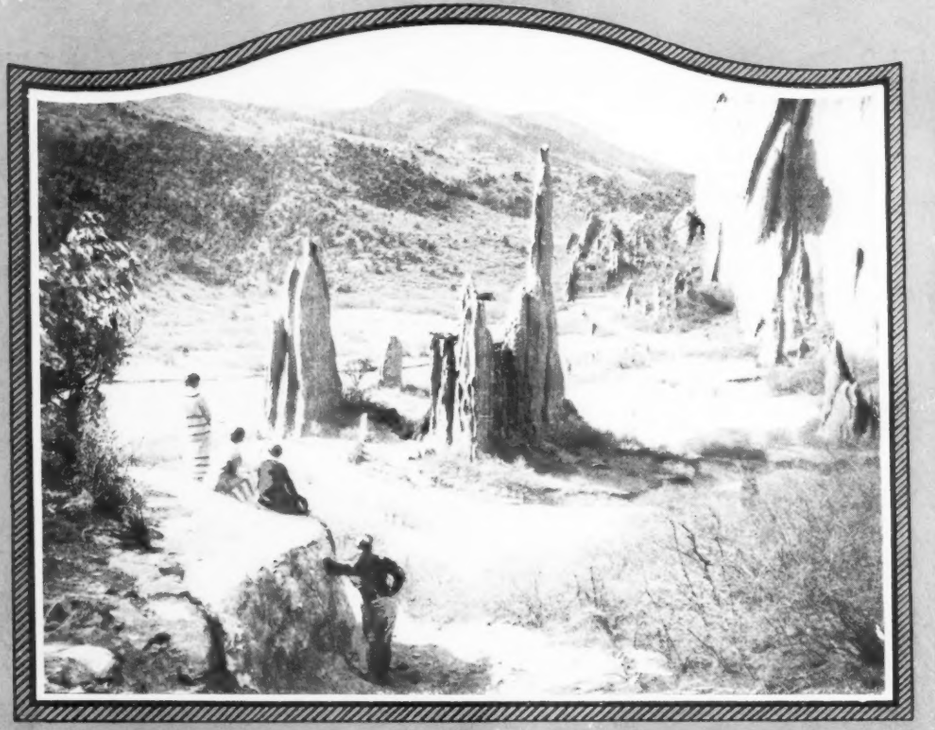

CATHEDRAL SPIRES AND GATEWAY ROCKS CARVED BY THE HAND OF TIME IN COLORADO'S GARDEN OF THE GODS

Compressed Air in the Modern Oil Refinery
V. M. Chatfield

Story of the Portland Gold Mine
C. H. Vivian

Centrifugal Pumps of Today and Half a Century Ago
Gail Martin

Enlargement of Hoosac Tunnel Completed
J. E. Harding

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N-701-L

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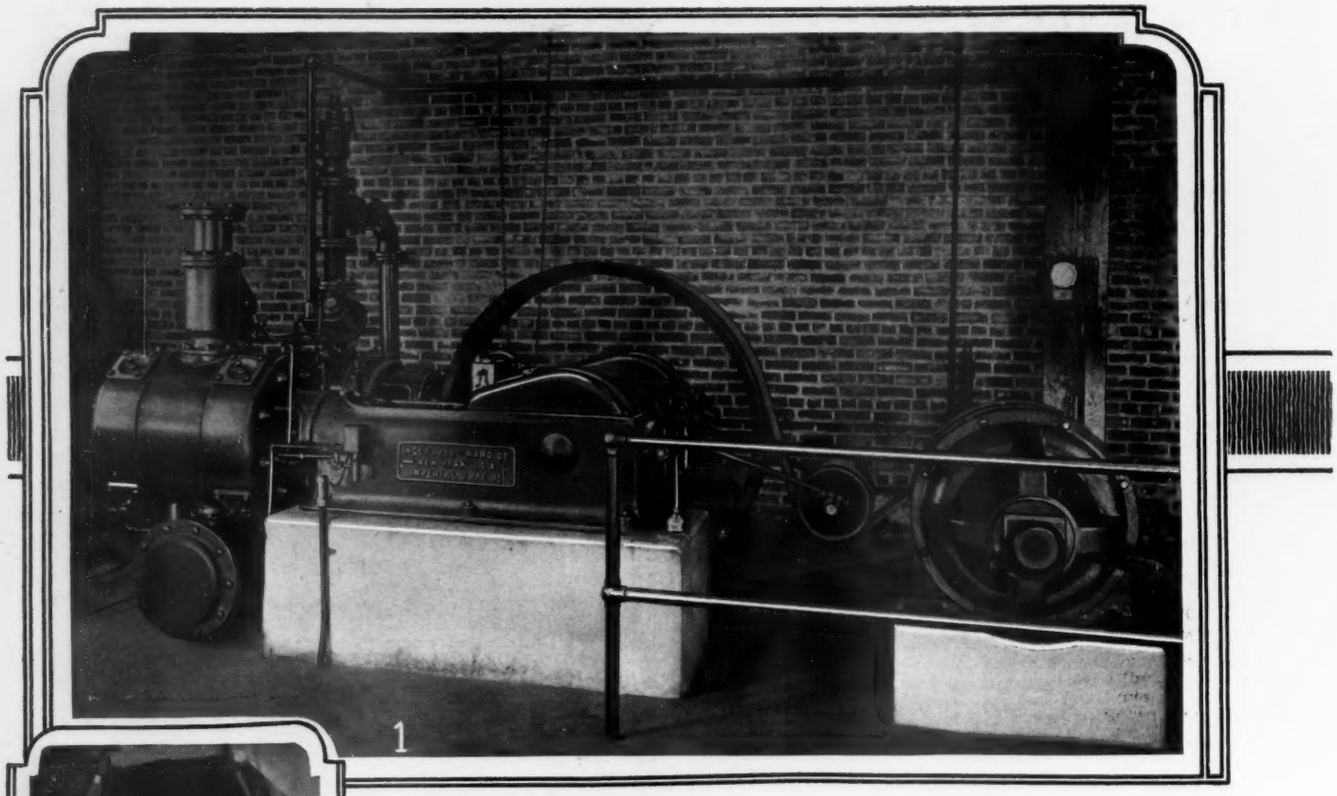

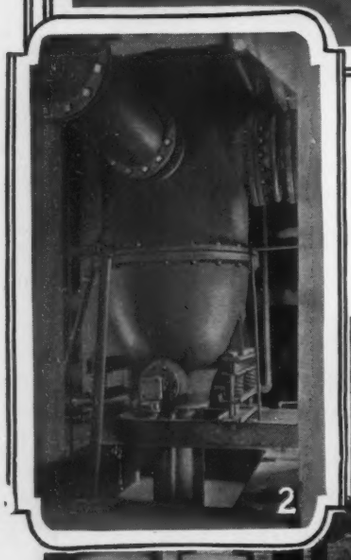

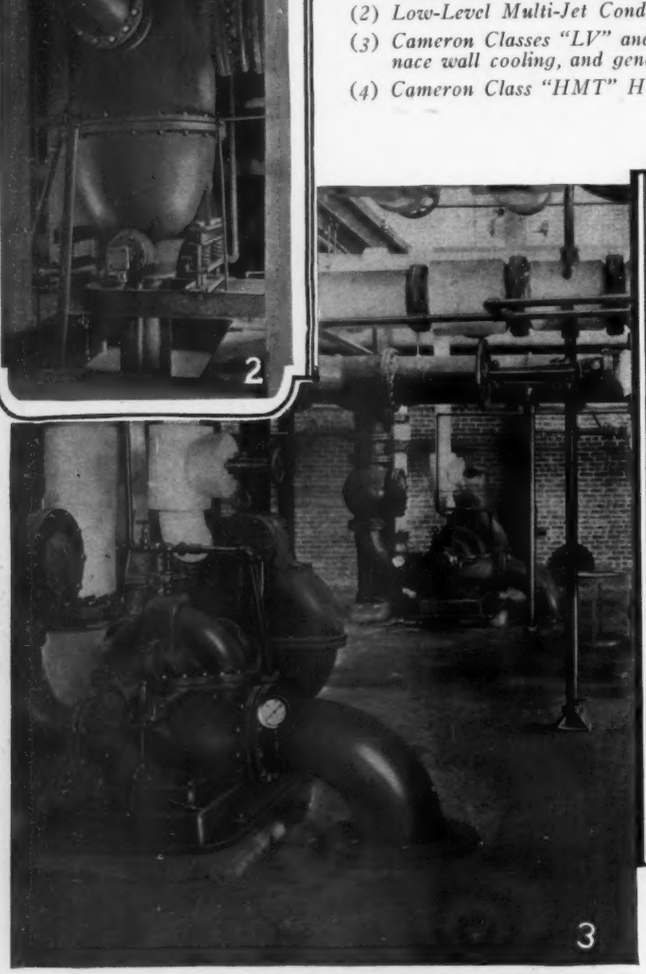

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(2) Low-Level Multi-Jet Condenser.
(3) Cameron Classes "LV" and "FV" Centrifugal Pumps for gas washing, blast furnace wall cooling, and general service.
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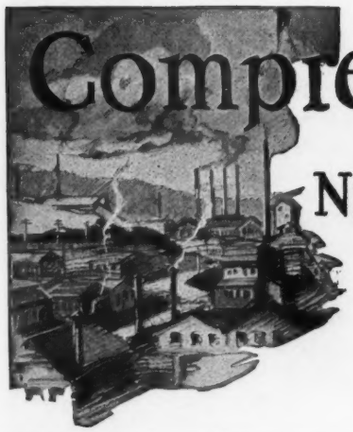

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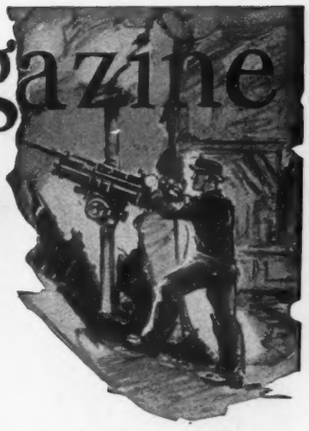

NEW YORK · LONDON · PARIS

Principal Offices
Bowling Green Building
No. 11 Broadway
New York.

VOL. XXXII, NO. II
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Compressed Air Magazine Co.
FEBRUARY, 1927

Compressed Air in the Modern Refinery

Where Every Effort is Made to Get the Greatest Number of Marketable Products From the Raw Material

By V. M. CHATFIELD*

IN the effort to obtain all possible values from crude petroleum, the refiner now employs more or less complex processes in which he utilizes heat, chemicals, and compressed air. How far compressed air is used is but little known by most of our readers. Not only that, but every plant of this many-sided nature offers numerous ways in which air can be put to service in building, repairing, or rehabilitating equipment and structures.

Often, the air-compressor plant is the first machinery to be put in place; and this compressed-air plant may be motor driven, steam driven, gas-engine driven or oil-engine driven. Furthermore, portable compressors are frequently seen in a refinery reservation providing motive power for much essential work.

The author has presented a fund of useful information about the refining of petroleum and the ways in which compressed air helps to make the various processes and the different products possible.

COMPRESSED air enters largely into both the construction and the operation of a modern oil refinery. During the construction period it is indispensable in the erection of tanks, towers, stills, agitators, and other steel units, and is utilized to operate riveting, chipping, and calking hammers, air drills, and other pneumatic tools.

As an example, let us take a storage tank of 55,000-barrel capacity. This is a standard-size tank, such as is in general use. A tank of this description is usually 114½ feet in diameter by 30 feet high, and is built in six rings with steel bottom and roof. The roof is supported on a structural steel framework that generally consists of a center column, two concentric circular rows of columns, and connecting beams carrying the roof plates.

In a tank of this size have to be driven approximately 50,000 rivets, and there is nearly a mile of seams to be calked. The calking is always metal to metal, no filler being permitted between the plates. Formerly, it was the practice to drive only ⅝-inch and larger rivets with the "gun"—the balance being driven by hand. But in the case of the last two large tanks built under the writer's supervision, all rivets were driven with the "gun," resulting in a saving in construction time and in the use of fewer rivets.

When it is considered that a refinery, aside from piping and pumps, is made up largely of structural-steel and plate work, the importance of compressed air in the construction of such a plant can be appreciated. But compressed air also has many services to perform in the operation of a refinery. It is employed for blowing out pipe lines after pumping. Any line not in continuous use, whether a suction or a discharge line, is usually blown clean immediately after a pumping is finished. This is especially true of heavy-oil lines and of all lines in winter service. For this purpose the air is taken from a receiver at from 80 to 100 pounds pressure—the pump-house manifolds being so arranged that air may be turned into any line by the pumper.

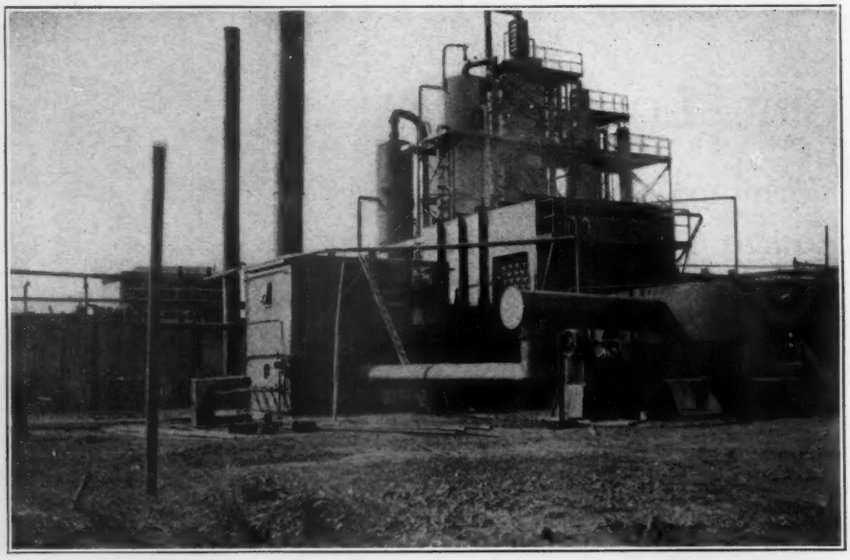
Compressed air is generally used in transferring chemicals—such as sulphuric acid or caustic solutions—from one point to another. In filling overhead tanks, the chemical is first run into blow cases having a bottom discharge. Air pressure is then applied to force the chemical into the overhead tank and to clear the chemical lines after the transfer is made.

Compressed air plays a useful part in certain automatic controls that serve to maintain predetermined liquid levels, pressures, temperatures, etc. In this field, the air pressure, governed by a regulating mechanism, operates a diaphragm valve to maintain the desired condition. Many plants are at present employing this type of apparatus to control the speed of pumps and compressors, to regulate the flow of water to condensers and dephlegmators, and to maintain liquid levels in towers and tanks.

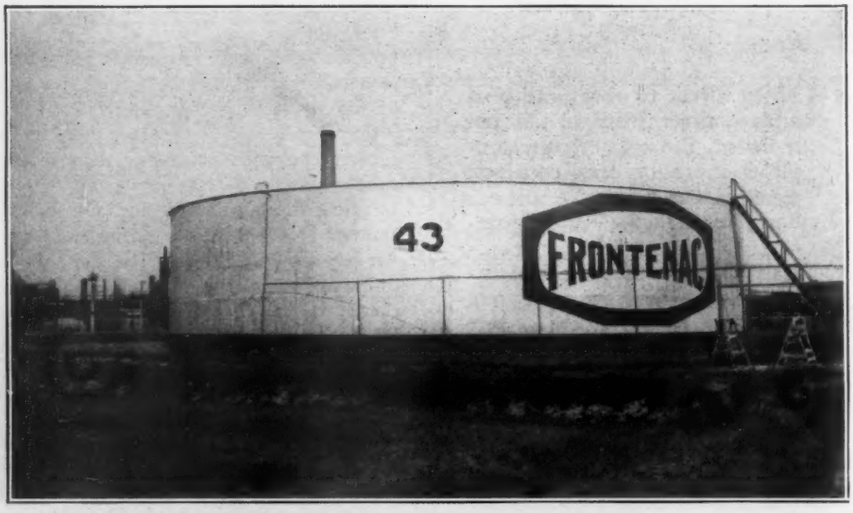
Air at low pressure is utilized for drying barrels after cleaning. In this work, the barrels are first steamed, bung down, and are next partly filled with a weak caustic solution and rotated mechanically. After they have been allowed to drain for about 20 minutes they are dried with a hot-air blast. About 15 cubic feet of air, at a pressure of from 4 to 6 ounces and heated to 225-250°F., is required per barrel per minute. Air is also used in the manufacture of wooden barrels, namely, for drying the staves after gluing and for testing.

Before a barrel is ready for service the inside must be coated with glue—about one-quarter pound of hot glue being introduced through the bung. The barrel is rapidly spun to distribute the coating; the bung is plugged; and air at low pressure is then applied to disclose leaks. With this done, the barrel is drained and aged for about a week before it is given a second coating as just described. Finally,

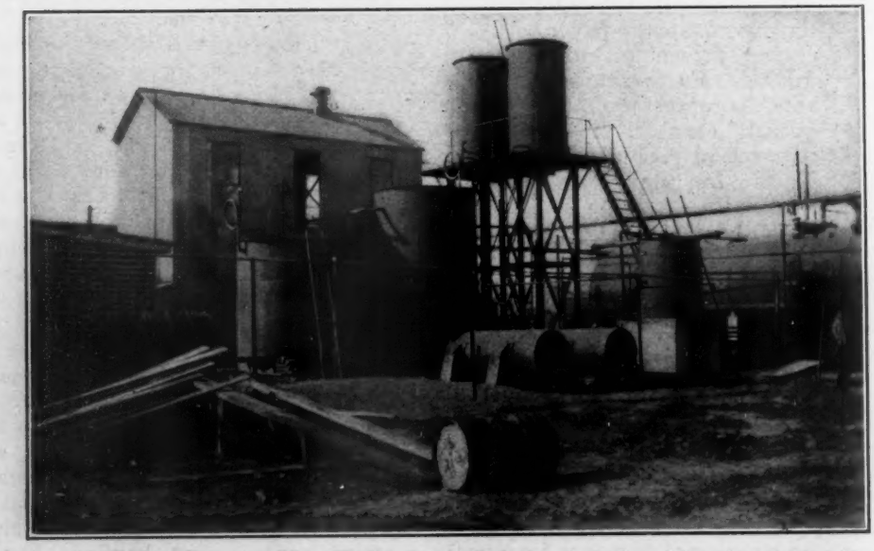
Resident Engineer, Frontenac Oil Refineries, Ltd., Montreal.



Large horizontal conduits in the foreground constitute the recirculating flue for handling flue gases.



A 55,000-barrel tank. It is 30 feet high and has a diameter of 114 feet 6 inches.



Continuous treating plant in which chemicals are transferred by air pressure to some of the tanks.

after the barrel has been dried with an air blast for from 6 to 8 hours it is ready for use.

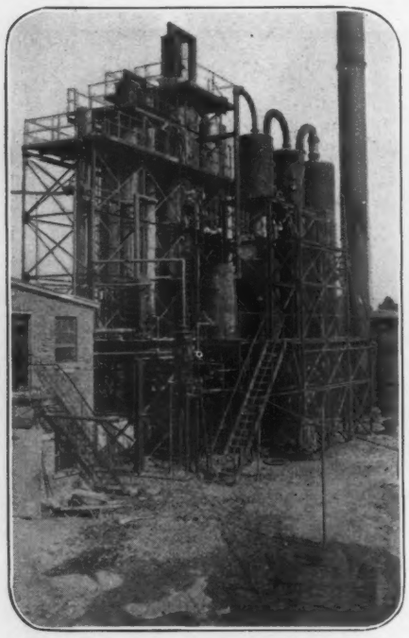
Air-blowing is an essential operation in the making of asphaltic products from petroleum. These products are prepared by subjecting petroleum residuum, or petrolene, to the action of heat and air that is blown into a suitable container for a definite length of time. To certain of the products, according to the characteristics desired, a natural bitumen known as Gilsonite is added during the aforementioned treatment. The products thus obtained are used, as indicated by an accompanying table, as a wood-block filler, road binder, mastic, pipe coating, paint, insulation, paving, flux, roofing, and in the rubber industry. It has been found that pure rubber is rather sensitive to extreme temperature changes. This disadvantage has been overcome by the admixture of certain asphaltic products containing 35 to 40 per cent. Gilsonite.

In the manufacture of asphaltic compounds, the crude petroleum is first reduced to petrolene in continuous stills or in a tube still—the production of a good grade of petrolene being the primary object and the distillates being of secondary importance in this operation. When the desired grade of petrolene is obtained it is charged into converters that are similar to stills. These converters are horizontal shells, about 10 feet in diameter and 30 feet long, set in bricks and fired much the same as is a horizontal shell still except that the converter's fire box is larger. Each converter is blown with air passing through about eight 1½-inch risers entering at the top of the converter from a common header and extending to within 8 inches of the bottom. There are independent lines for charging, drawing off, sampling, and for fume disposal, while Gilsonite is charged through a manhole on top. A separate manhole is provided for cleaning.

In the process, the petrolene is gaged, charged into the converter, and the line is blown. Fire is applied gradually until the water is driven off, when the fires are increased until the temperature is about 375°F. If the product desired requires Gilsonite, this material is then added, and the air blast started. For most products the temperature at this point is raised to 450°F. and held there. In the case of higher melting-point products, such as those used in rubber manufacture, Gilsonite is added and the temperature at that stage raised to 475-500°F. Twelve hours after the air blast is turned on the first sample is drawn and tested for melting point and penetration. Thereafter, samples are taken at 3-hour intervals until the batch is finished.

It has been found that air blowing increases the melting point but has little effect on penetration. At high temperatures, the introduction of air will keep the temperature up to the desired degree. Cooking in the converter without the air blast tends to lower the melting point but has only a moderate effect on penetration. Gilsonite serves to raise the melting point slightly and to lower penetration, while the addition of petrolene has the opposite effect .

Two gushing oil wells in a prolific Texas field.



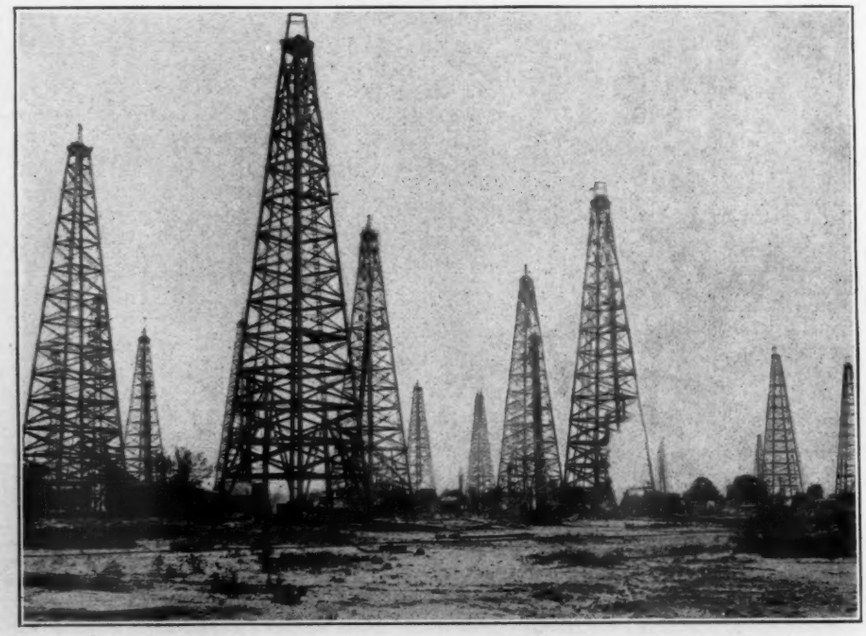
Fractionating towers showing type of steel structure used to support them.

Another important use of air in oil refining is in the treating of gasoline, kerosene, and lubricating oils, and in the regeneration of the sludge acids recovered. In general, the objectionable bodies to be removed by treatment are certain unsaturated hydrocarbons, sulphur compounds, and minor impurities. Unsaturated hydrocarbons—with the exception of di-olefines, which leave tarry deposits after combustion in the motor cylinders—are now considered by many authorities to be among the most valuable constituents of gasoline for motor use. Sulphur compounds cause very disagreeable odors.

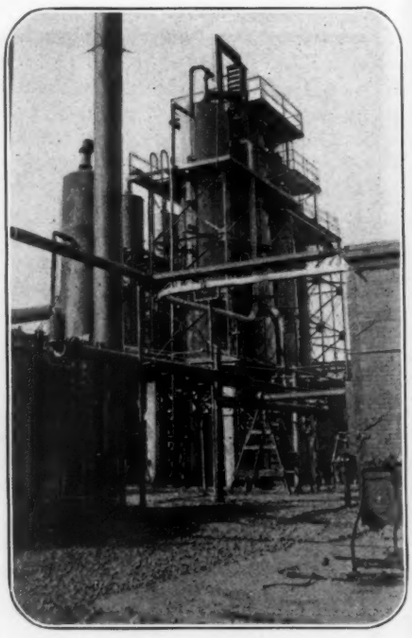
On the other hand, in oils used for burning, the unsaturated bodies are highly undesirable. These compounds are not completely oxidized when the oil is burned, and produce a smoky flame. Sulphur compounds are often the cause of carbonization on the lamp wick, and must be removed. In lubricating oils, we find a difference of opinion among the various authorities as to the treatment to be applied. Some claim that certain unsaturates will break down under high temperatures and deposit free carbon. Others believe that these naphthenes possess desirable qualities, and that they should be treated only for the purpose of improving the color of the oil. In any cause, it is usual to give lubricating oils a thorough treatment.

Gasoline may be treated in the ordinary type of air-blown agitator, or in the more modern closed, continuous treater. Kerosenes and lubricants are almost universally treated in the air-blown type of agitator. This is a cone-bottomed, upright, cylindrical tank lined with sheet lead—a sheet lead containing 6 per cent. antimony now being largely employed for this purpose on account of its greater durability. The agitator is fitted with charging and draw-off lines, chemical and steam lines, water sprays, and an air line which enters at the top of the agitator and extends well down into the cone. Each distillate presents its individual treating problem, and no definite treating rules can be laid down. In general, however, it is desirable to give only sufficient agitation to insure complete contact of the oil with the reagent, and to do enough washing and settling to remove all chemicals, sludge, and water from the batch. A typical light-oil treatment is as follows:

The agitator is charged—the amount of acid added depending on the oil undergoing treatment. This may be from 1 to 6 pounds per barrel. After the batch has been thoroughly agitated with air for from 15 to 20 minutes it is allowed to settle for an hour or two to permit the sludge to reach the bottom. Water is sprayed in to remove traces of the acid, and the sludge and water are drawn off. Next, soda or sodium plumbite solution, followed by more water, is introduced through the upper spray, and then the batch is again agitated with air for from 15 to 20 minutes and allowed to settle. In order to remove all soda, the batch is given a warm-water wash—the temperature of the water being at about 100°F. After that the batch is finished and may be drawn off. The total time from batch to batch is from six to eight hours.



A section of a Texas oil field that is being extensively worked.



Fractionating or bubble towers at the plant of the Frontenac Oil Refineries, Ltd.

The treatment of lubricating oils involves some problems worthy of mention. In most large refineries it is now customary to give the acid treatment in one agitator and to transfer the charge thence to a wash agitator for the balance of the treatment. The reason for this is that long delays may be encountered in overcoming emulsions, or the removal of all moisture may offer difficulties. Therefore, three or four wash agitators, serving each treating agitator, will keep the treater in continuous use. Except for the fact that it is usually not lead lined, the wash agitator is like the treating agitator in construction. The cone in each case is fitted with open steam sprays and closed steam coils because the lubricating-oil treatment is usually carried on at temperatures ranging between 150 and 200°F. Both types are insulated with hollow tile—a small air space being left between the tile and the shell of the agitator. Wash agitators are sometimes built with concrete roofs supported on the tile insulation. These roofs are independent of the agitator so as to overcome the objectionable condensation of moisture on the underside of the roof.

The following is a typical treatment given lubricating oil made from a Texas paraffin base crude: The agitator is

charged, and the proper amount of 98 per cent. sulphuric acid is added. This may range all the way from 30 to 50 pounds of acid per barrel of charge. The charge is then blown with air for from 15 to 30 minutes, followed by a moderate water spray. Next, the batch is settled for one hour and the sludge drawn off. The batch is now transferred to a wash agitator where a soda solution is added and the charge is air-blown. Great care must be taken to avoid the use of an excess of soda, as it is apt to cause emulsification. After blowing, the charge is heated to 180°F. and permitted to settle for several hours, when the sludge is drawn off. Steam is then applied through the open sprays in the cone for a period of two hours to remove any remaining soda; the batch is settled for several hours; the sludge is again drawn off; steam is applied to the closed coils to maintain the temperature at 180°F., and the batch is blown with air to remove the moisture. This operation is termed "blowing bright," and may require from 4 to 24 hours, depending on atmospheric and other conditions. The full treating cycle needs from 18 to 36 hours.

The spent acid from the treatment of petroleum products must either be allowed to run to waste or be recovered as strong acid. This is not a serious problem in the ordinary skimming plant that treats light oils, as the amount of acid used is not large and may be run to waste. There is no great danger of stream pollution, because the acid will enter the sewer system in combination with the alkaline sludge and the wash water, which will largely tend to neutralize it. Besides, the acid will be considerably diluted by the general waste water from the refinery. Light oils require only from 1 to 6 pounds of acid per barrel treated. In lubricating plants, however, as high as 60 pounds of acid per barrel may be needed. Furthermore, the acid sludge is of a different kind—of a dark viscous nature, containing oil, acid, and asphaltic bodies. Both the difficulty of disposal and the value of acid make it necessary to resort to recovery.

To recover the acid, it is first necessary to separate the oil and the asphalts from the sludge. This is accomplished in lead-lined tanks having either a sloping or a conical bottom and an inner lining of acid-proof brick to protect the lead when cleaning. Separation is effected by blowing with air, followed by settling at temperatures up to 200°F. The sludge separates into three layers: a top layer of acid oil; a center layer of weak acid; and a bottom layer of asphalts or "acid cake." The oil may be neutralized and reduced in stills to pitch. The acid cake—a heavy tar that becomes granular when washed with water—is not unlike coke, and may be burned when mixed with coal or may be neutralized and fluxed with lighter oil and used for refinery fuel. The weak acid is then concentrated to 66° Baumé.

Concentration may be effected in lead-lined

Platform for loading tank cars.

Tank farm. The dark tanks contain fuel oil and intermediates. The white tanks contain crude and light oils.

Numerous horses are needed to draw heavy pieces of machinery into the oil fields over nearly roadless country.

pans or by the more modern tower system. In the first case, the acid flows by gravity through a series of lead-lined pans, about 12 inches deep, placed over flues carrying hot combustion gases. The pans will reduce the acid only to about 60° Baumé—further concentration to 66° calling for the employment of cast-iron acid stills. The tower system is well exemplified by the patented method of the Chemical Construction Company. This method makes use of hot air, which is blown through the acid to be recovered, thereby lowering the boiling point of the acid—in accordance with the law of partial pressures—through the direct introduction of air into the acid. When concentration is brought about in this way, acid is contained in a rectangular lead pan that is lined with acid-proof brick and topped with a brick arch through which the hot air pipes are led. Over this is a tower of acid-proof tile, loosely packed. The weak acid is carried to the top of the tower by an air lift. In its descent, the acid scrubs the ascending vapors and absorbs heat, falling into the pan at the bottom of the tower through which hot air is blown. After it is withdrawn, the acid is again carried by air lift to the top of a second and similar tower, where the operation is repeated. In the first stage the acid is concentrated to 57-60° Baumé, and in the second stage to 66° Baumé. The air used is preheated in a furnace to 1,100-1,200°F., and is discharged under the surface of the acid bath.

GENERAL SPECIFICATION OF 55,000-BARREL TANK

Description of Part	Steel Thickness	Rivets Vertical	Rivets Horizontal
First ring	9/12-inch	7/8-inch triple	3/4-inch single
Second "	15/32 "	3/4 " "	3/4 " "
Third "	11/32 "	3/4 " double	3/4 " "
Fourth "	5/16 "	5/8 " "	5/8 " "
Fifth "	1/4 "	7/16 " "	7/16 " "
Sixth "	1/4 "	7/16 " single	7/16 " "
Bottom plates	1/4 "		7/16 " "
Roof "	1/4 "		3/8 " "

Top angles, 3½x3½x⅝-inch, 7/16-inch single rivets.
Bottom angles, 4x4½-inch, ¾-inch single rivets.

Compressed air has much other work to do about a refinery in connection with sand blasting and spray painting, in pumping water by means of the air lift, in atomizing fuel oil in firing oil burners, and in operating air hoists and pneumatic tube cleaners for boilers and tube stills. This is what might be called secondary work, and is mentioned merely to emphasize how necessary compressed air is to the effective operation of a modern refinery.

NEW SOURCE OF RUBBER

SOUTH Africa is being hailed as a potential source of raw rubber as a result of extended chemical research work in connection with the latex of the euphorbia tree. It is said that American capital has been convinced that the process is commercially practicable; and that plans are now underway to locate the first unit of the new industry at Kingwilliamstown.

The euphorbia tree is a common one in South Africa, occurring by the millions. It has been found that the latex contains from 15 to 30 per cent. of rubber and also about twice as much of resins. Tests are said to have demonstrated that the rubber vulcanizes well and that it is applicable to use in low- and medium-grade goods. The resins are valuable, particularly for varnishes.

LARGE PLANER HAS OWN AIR COMPRESSOR

WHAT is reported to be the largest planing machine ever built has recently been turned out in the United States. It is electrically driven by a number of motors ranging from 7 to 100 H. P. each. Air-operated friction clutches for stopping and starting are a feature of the machine. Because of the great weight of the materials commonly planed, the feed is also controlled by compressed air—the feed-cylinder air valve being automatically operated at the end of each stroke.

While the use of compressed air for actuating clutches and for feeding has previously been employed on planing machines, this planer is the first to have its own compressor. This unit is driven by a 30-H. P. motor, and the air is stored in a large receiver. The entire machine weighs 422 tons, and its total power equipment is 207 H. P. Because of foundry limitations and transport problems, the bed of the planer was cast in seven parts and the table in two parts. The table is 32 feet long, 15 feet wide, and has a stroke of 30 feet. The bed has a length of 60 feet, a width of 13 feet, and is 6 feet 1 inch deep at the center.

ASPHALTIC PRODUCTS FROM PETROLEUM, GIVING PHYSICAL CHARACTERISTICS, USES, ETC.

Number	Per cent. Gilsonite	Penetration Humbolt Penetrometer 32° F.	77° F.	115° F.	Melting Point 2½ grams	Ductility (CMS) Dow	Cross	Specific gravity	Flash point N. Y. closed cup	Fixed carbon	Per cent. ash	Per cent. soluble in carbon disulphide	Organic insoluble	Air blown	Total hours after 12 hours	Uses
1	20	30	45	94	150	3	1½	0.993	495	13.25	.15	100.0	..	Yes	30	Wood-block filler
2	12	42	62	96	170	5	2	0.989	496	13.25	.15	99.92	..	"	34	Waterproofing
3	26	23	38	62	170	7	3½	0.986	500	13.00	.15	100.00	..	"	35	Mastic
4	17	29	38	59	195	4	1¾	0.988	496	13.50	.15	99.91	..	"	37	Pipe coating
5	13	30	38	59	200	4	2	0.988	496	13.75	.15	99.94	..	"	39	Filler
6	26	14	18	31	220	4	1½	0.990	507	14.00	.16	99.89	.04	"	58	Mastic
7	12	30	42	56	225	3	1	0.990	496	14.50	.15	100.00	..	"	44	Roofing
8	60	2¾	4½	7¼	230	..	..	1.016	512	14.25	.26	99.89	..	"	34	Paint
9	18	17	23	34	245	3	1½	0.993	495	15.47	.17	100.00	..	"	60	Mastic
10	27	8	13	19	270	..	..	0.996	514	15.17	.24	99.82	..	"	85	Insulation
11	40	3	5	8	325	..	..	1.008	518	15.50	.36	99.81	..	"	144	Mineral rubber
12	35	3	5	8	400	..	..	1.029	515	18.39	.34	100.00	..	"	190	" "
13	22	57	90	230	125	44	?	0.991	496	12.00	.15	100.00	..	No	36	Paving
14	24	48	68	210	130	35	?	0.991	497	12.00	.15	100.00	..	"	33	"
15	28	41	60	194	135	2.8	?	0.991	496	12.50	.15	100.00	..	"	36	"
16	..	116	168	240	150	2	1½	0.970	494	13.50	.15	100.00	..	Yes	28	Flux
17	..	100	155	220	180	2½	1¼	0.974	495	13.50	.15	100.00	..	"	36	"
18	..	65	95	130	190	3	1½	0.976	496	14.50	.15	100.00	..	"	42	Road binder
19	..	63	88	116	200	2½	1¼	0.977	496	14.50	.15	100.00	..	"	45	" "
20	..	40	60	90	225	2½	1¼	0.978	497	15.25	.16	100.00	..	"	52	Roofing
21	..	32	43	70	250	2	1	0.978	496	15.25	.16	100.00	..	"	65	Filler
22	..	29	38	59	260	2	1	0.978	502	16.00	.17	100.00	..	"	72	"
23	..	29	37	55	275	1¾	⅞	0.980	503	16.50	.18	100.00	..	"	86	"

Cost of Power Per Ton of Rock Quarried

By EDWARD DALTON*

MUCH has been said and written about the cost of power and the best methods of generating power under the many different conditions which exist throughout the realm of industry. During recent years the Diesel and other types of oil engines have come in for a large share of this discussion. This is not to be wondered at, as the internal-combustion engine is no longer an inventor's dream or a mystery to the average man.

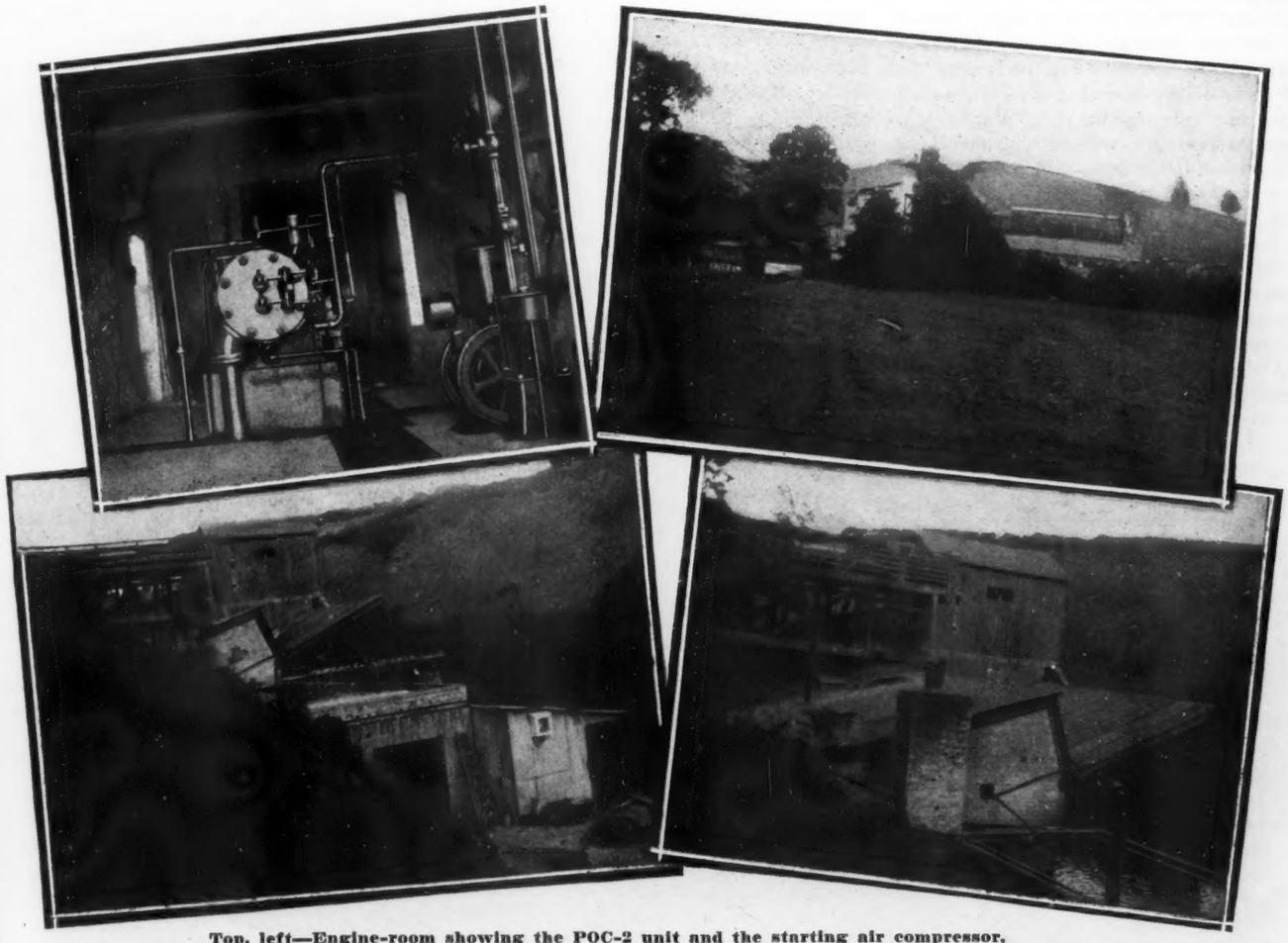
The development of the oil-engine merchant ship, of the oil-engine locomotive, and of large oil engines for generating stations that supply the public has brought this type of prime mover before the eyes of executives and to the attention of the general public. In the British Isles some particularly interesting discussions have taken place. For instance, at the last annual meeting of the Institute of Quarry Managers much time was devoted to the subject of oil engines. Since then numerous articles have appeared in the *Quarry Manager's Journal,* which is the official organ of the Institute.

The writer, who is a member of the Institute and who has for many years been closely associated with the quarry trade, has naturally taken an active part in these discussions. The thing that interested him most was the endeavor to find a way that would make it possible to express the cost of power in terms of quarry output. In other words, "What is the cost of power per ton of rock quarried?" If expressed in this fashion every quarry manager could tell immediately what form of prime mover would be most suitable and most economical for his purpose. Most power comparisons are based on the cost per brake-horsepower hour or per kilowatt-hour, which figure must then be converted into tons of rock before the quarryman can make a comparison with which he can work.

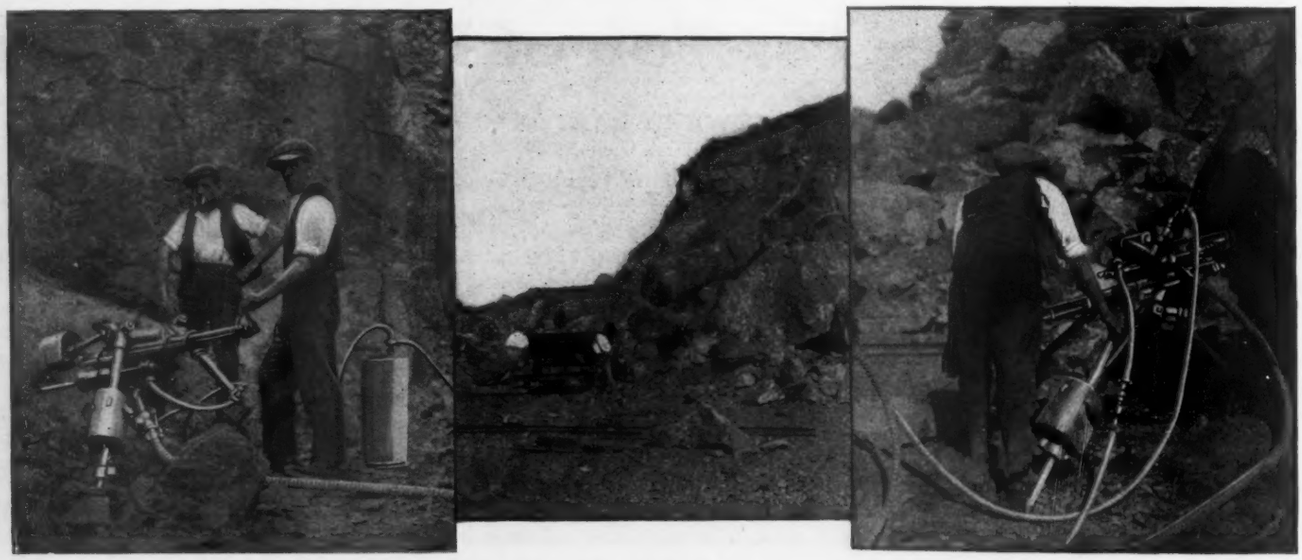
It is apparent that such costs are not easy to compute—local conditions, such as wages, cost of fuel, cost of transportation, etc., affecting each case. Also, the quality of the rock quarried must be taken into account; the tonnage desired has a bearing on the calculations; and the type of rock drill used should be considered. In spite of these varying conditions, any figure that will accurately give the results obtained in any one quarry should be of interest, especially if the conditions existing in that quarry are known.

In the December, 1925, issue of this Magazine, the writer described in detail the plant which is in use at the quarry of the Scatter Rock Macadams, Ltd., at Christow near Exeter, Devon, England, as well as the method of drilling and the footage secured with that equipment. It will, therefore, suffice for our present purpose if we repeat here that the plant consists of an Ingersoll-Rand Type POC-2, direct-connected, oil-engine compressor, having a piston displacement of 603 cubic feet per minute. This machine furnishes the air necessary to operate an X-70 drill, two BCR-430 "Jackhamers," a DCR-13 "Jackhamer," and

General Manager, Scatter Rock Macadams, Ltd.



Top, left—Engine-room showing the POC-2 unit and the starting air compressor.
Right—Granulating mill of Scatter Rock Macadams, Ltd.
Bottom, left—An inclusive view of the crushing house and the oil-engine room.
Right—Cooling-water tank for the oil engine is located on the roof of the engine-room.



Left—An X-70 drill putting in toe holes.
Center—Loading cars with rock after a blast in the quarry.
Right—An X-70 drill used for blockholing large boulders.

two DDR-13 "Jackhamers." The hollow steels which are employed with all these drills are prepared on a No. 50 "Leyner" sharpener—the heating of these steels being done by a "Leyner" oil furnace.

The 100-H.P. oil-engine power plant, which superseded a belt-driven compressor installation, has now been in service for more than sixteen months. A very careful analysis has been made of the operating costs of the oil-engine unit covering the first year of this working period—the writer's intention being to determine the cost of running the compressor so that figures might be made available showing the actual cost of power per ton of rock required. The results are most interesting and show that the present cost is only 25 per cent. of the cost prior to installing the oil-engine unit.

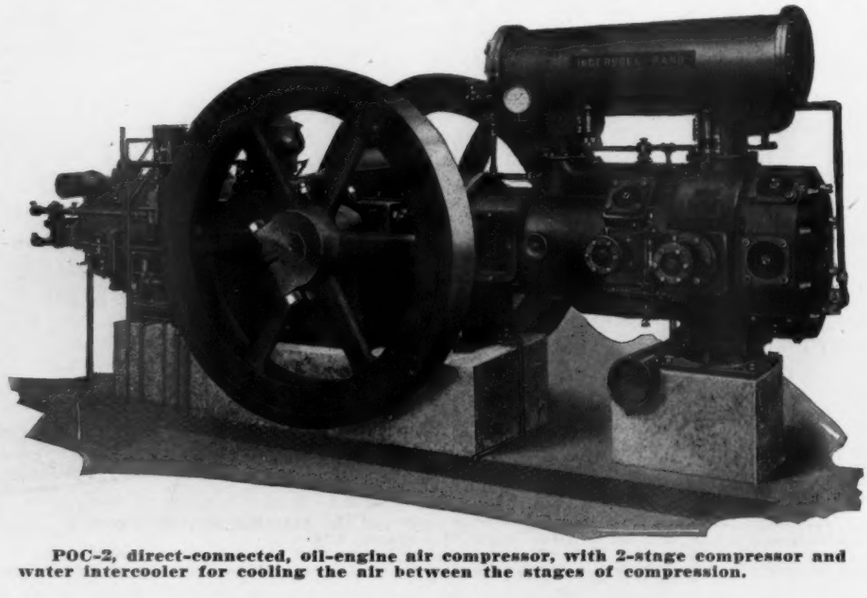
As near as can be ascertained, the consumption of fuel oil is at the rate of 0.40 pound per brake horse power per hour. It is estimated that the average load factor of the compressor, during its daily 8-hour shift, is approximately 50 per cent. Actual results for the year indicate that the average fuel-oil consumption per engine-hour is 16.2 pounds. While the foregoing data is interesting from the standpoint of oil-engine economy, still the following table gives the actual running and upkeep cost of the POC-2 oil-engine compressor plant per ton of rock quarried. For the sake of convenience, the cost figures are both in English and American currency.

	Attendance Charges		*Lubricating Oil*		*Fuel Oil*	
1925	*Pence*	*Cents*	*Pence*	*Cents*	*Pence*	*Cents*
June	.36	0.72	.29	0.58	.43	0.86
July	.50	1.00	.08	0.16	.68	1.36
Aug.	.77	1.54	.24	0.48	.70	1.40
Sept.	.53	1.06	.10	0.20	.70	1.40
Oct.	.51	1.02	.06	0.12	.61	1.22
Nov.	.52	1.04	.11	0.22	.62	1.24
Dec.	.74	1.48	.09	0.18	.59	1.18
1926						
Jan.	.99*	1.98	.25	0.50	.81	1.62
Feb.	.47	0.94	.27	0.54	.62	1.24
Mar.	.41	0.82	.08	0.16	.55	1.10
Apr.	.47	0.94	.07	0.14	.53	1.06
May	.45	0.90	.12	0.24	.47	0.94
Average	.56	1.12	.146	0.29	.61	1.22

**Due to overhauling stone-breaking plant.*

Accordingly, the average cost for fuel and lubricating oil per ton of rock quarried is .75d. or 1.5 cents. It might be well to mention in passing that the fuel oil used is known as gas oil, a good grade of Diesel oil, with a gross calorific value of approximately 19,400 B.T.U.'s per pound; and the figures are based on fuel oil costing 6.25d. (12.5 cents) per gallon and lubricating oil costing 3s. 6d. (84 cents) per gallon at the compressor.

Another interesting fact brought out during the first year's operation was that the compressor during that interval required no spare parts. This was beyond expectations, as the writer, like many others, had always understood that while an oil-engine plant of the type described is economical in the use of fuel the resultant savings are wiped out because of excessive repair-part charges. Certainly the twelvemonth service record of the oil-engine compressor at the quarry of the Scatter Rock Macadams, Ltd., not only disproves this statement but shows that the plant, when properly looked after, will not involve heavy upkeep costs.



POC-2, direct-connected, oil-engine air compressor, with 2-stage compressor and water intercooler for cooling the air between the stages of compression.

Black sands, of which there are huge deposits on the Queen Charlotte Islands, B. C., yield a high-grade pig iron, according to word from Vancouver. A process of extraction has been developed; and, as a result of experimental work, a plant is to be established at Port Moody, B. C., with a daily capacity of 30 tons of pig iron.

Centrifugal Pumps of Today and of Half a Century Ago

By GAIL MARTIN

THE story of the evolution of the indispensable pump is a fascinating one and takes us back to the earliest days of our civilization. Its first pages were written when mankind began to emerge from savagery; and its history is intimately associated with progress the world over—progress in agriculture, mining, in fact, in well-nigh every department of industry. It is only when one knows the story that lies behind the powerful pump of today that one can appreciate what has been accomplished in this field of engineering.

Man's first pump, so we are told, was conceived by an unknown Egyptian, and consisted of a bucket attached to the end of a pole secured to a post. This contrivance is called a well-sweep, and is utilized to this day to dip water in Asia—the bucket with its load being raised either by man or by horse power. Although the Persians developed the Persian wheel, the great Roman engineer Vitruvius invented the rotary waterwheel and spiral pumps during the first century before Christ, and the Chinese are credited with having used steam for lifting water, still the Egyptian well-sweep stands as a prototype of the modern centrifugal pump with its fanlike impeller turning hundreds of revolutions a minute and forcing water surfaceward with such speed and in such volumes as were undreamed of by engineers of ancient days.

Some of the separate homes and administrative buildings on the mine property in the town of Keetley.

This type of pump has reached a high stage of development in the past 50 years. What has been achieved can best be made clear by describing the pumping equipment used by one company throughout that interval for a certain kind of work—that, for example, of unwatering mines. For the present purpose, it should be of interest to both the engineer and the layman to contrast the new Cameron centrifugal pumps recently installed by the Park-Utah Consolidated Mines Company, Park City, Utah, on the 1,800-foot level of the Park-Utah Mine with the huge Cornish pump put in operation by that company just 45 years ago in the adjoining Ontario Mine.

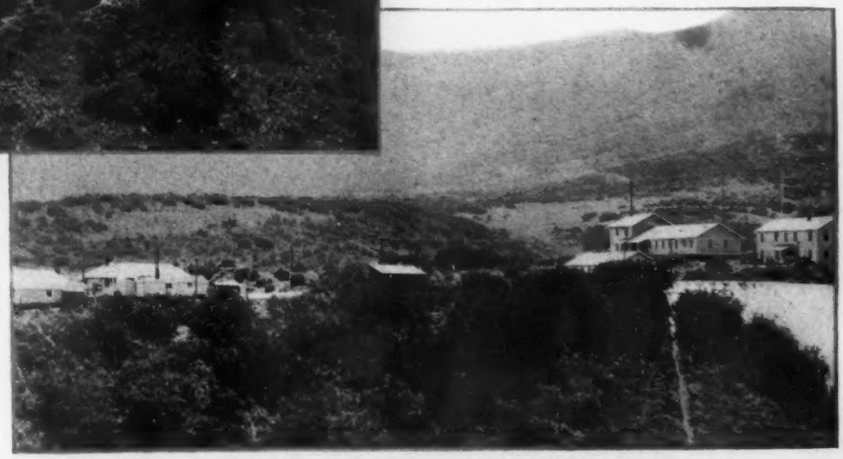
In 1881, the management of the Ontario purchased, at an outlay of $137,000, a Cornish pump reputed to be the largest of its type ever set up in the United States. The total cost of the pump and of its installation amounted to $750,000. This pump had a flywheel that was 35 feet in diameter and weighed 50 tons. Each of its high-pressure cylinders was 38½ inches in diameter and each low-pressure cylinder 70 inches.

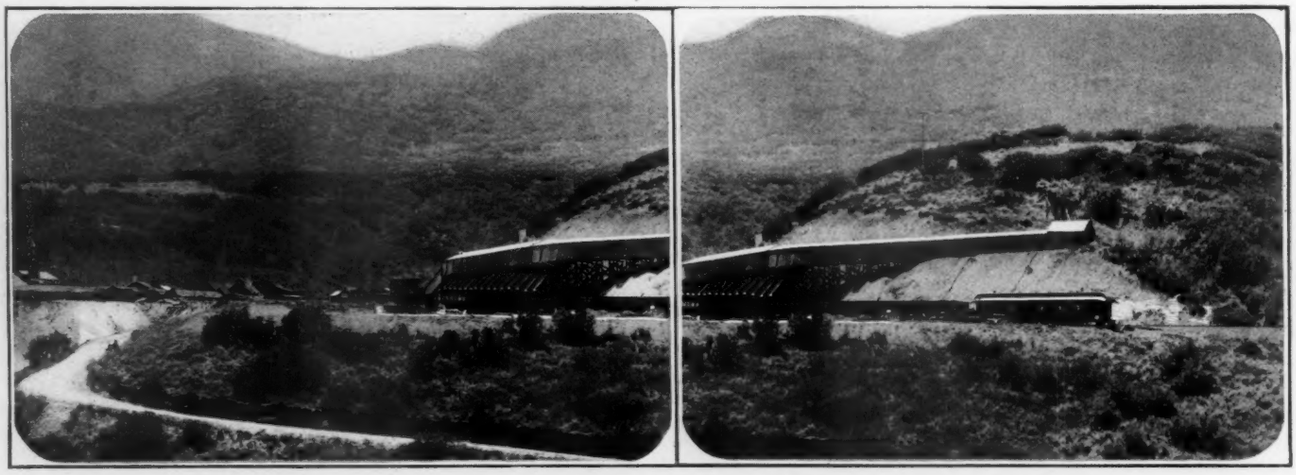
The 1,500-foot pump rod was made of 100-foot sections of 16x16-inch Oregon fir. Adjoining sections were fastened with 1x10-inch strap iron, 35 feet long, specially rolled and made in Norway of Norway iron. Balance bobs to counterbalance the enormous weight of this pump rod were built into the shaft at intervals of 400 feet. The monster engine was placed on a foundation 40 feet deep. In fact, over 7,000 cubic yards of masonry work had to be done in setting up the pump. At each stroke the pump lifted 320 gallons of water; and the capacity per minute was 2,560 gallons.

As a reserve, in case accident should force a shutdown of the Cornish pump, the company installed a Knowles compound, condensing steam pump with 14-inch plungers on every sixth level, or one to each 600 feet of shaft. To operate this equipment it took twenty-six 50-H.P. boilers that consumed 145 tons of coal daily. Extravagant as the Cornish pump was as compared with the Cameron centrifugal pumps now in use in the Park-Utah, it was extremely economical in contrast with the Knowles pump. To do the same amount of work, the Cornish pump required but four pairs of boilers.

At the Ontario Mine, on the 1,700-foot level, can still be seen an old Knowles pump that sprawls out like some prehistoric monster for a distance of 40 feet. In comparison, the new centrifugal pumps of the Park-Utah are impressively compact. They weigh but 3,000 pounds each as against the 40 tons of the Knowles pump, and they take up but a fraction of the space and cost considerably less than the old equipment. One looks like a worn-out engine of ancient warfare, the other is business-like in its appearance and works quietly, ceaselessly—accomplishing far more at less effort and cost than the old pump that did its labor to the accompaniment of an ear-wracking din.

The noise made by the Cornish pump when in action was deafening—the escape of steam, the thunder of the pump rod, and the rattle of machinery combining to make the place sound like a boiler factory. In contrast, the operation of the new plant at the Park-Utah is well-nigh noiseless. One would hardly know, save for the hum of the swiftly revolving motor, that a 14-inch stream of water was being raised 300 feet to the 1,500-foot level. The balance of the impellers is so extremely delicate and the movement of those wheels, whirling at a rate of 1,800 revolutions a minute, is so smooth that a silver dollar upended on the pump cas-





Ore loading station and branch of the Union Pacific Railroad that serves the Park-Utah Mine.

ing will hold its equilibrium when the pumps are lifting 3,000 gallons a minute.

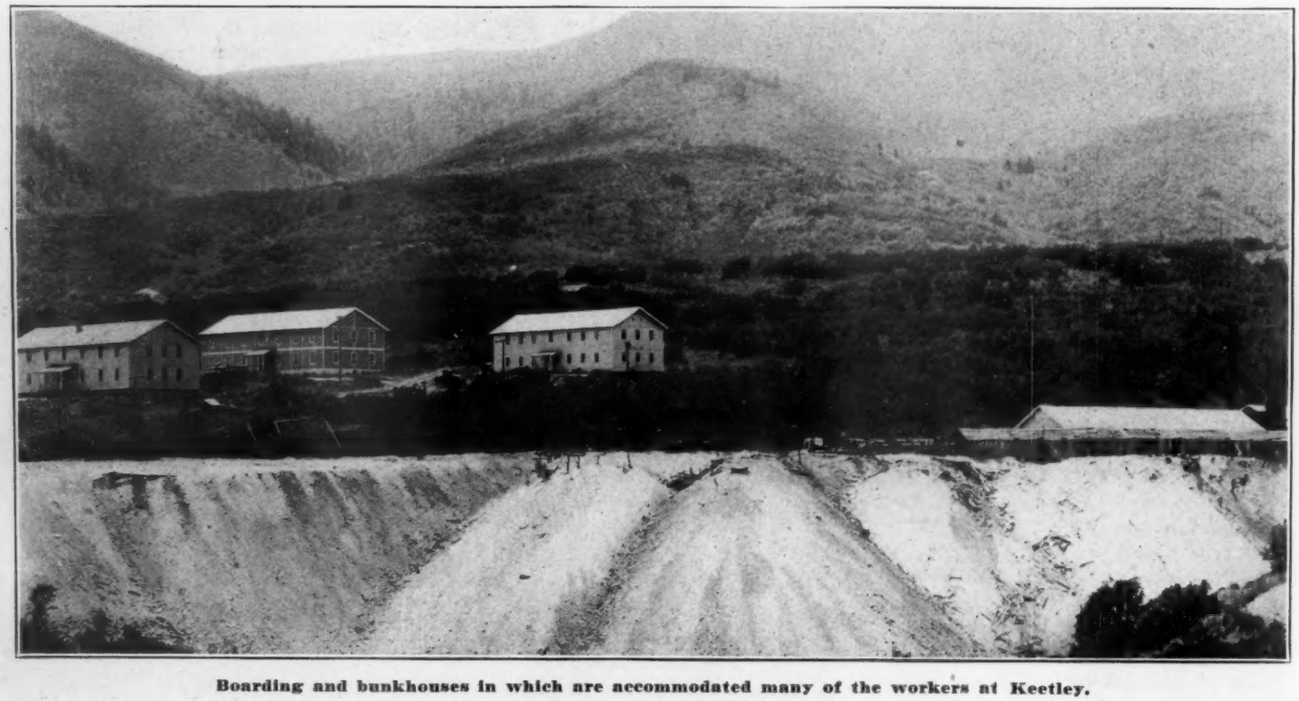
Insignificant in appearance as is the Park-Utah pumping plant, it can handle three times as much water as the colossus of the "eighties" in the Ontario. Even with the present high cost of labor and of machinery, the first cost and the upkeep cost of the new plant are lower than they were in the case of the Cornish pump. The engineering staff of the Park-Utah Consolidated Mines Company has computed that the complete first cost per 100 H.P. delivered by the new plant amounted to $20,000, and that of the old Ontario to $125,000. The annual operating cost per 100 H.P. delivered by the Cameron pumps is $14,000, while that of the old Ontario plant was $45,000.

The Park-Utah pumping plant is housed in a 28x35-foot station. On the other hand, the Cornish pump and engine required a building 58x48 feet. The operation of the new pumps is practically automatic, while the equipment in the Ontario necessitated the constant attention of a small army of pumpmen, engineers, firemen, and mechanics.

The Cameron centrifugal pumps of the Park-Utah are worthy of study from still another angle that illustrates the possibility of delivering water to the main centrifugal pumps without priming or submersion of the pumps, thereby eliminating all the bothersome details sometimes involved in the operation of centrifugal pumps and assuring, at the same time, a maximum of efficiency at a minimum cost.

A variation in the degree of vacuum resulting from differences in altitude often reduces the capacity of centrifugal pumps. To cope with this problem, an understanding should be had of the action occurring at the suction of a pump. Water suddenly placed under a vacuum effervesces or boils as a result of the release of air and gases in the water as well as of the actual boiling of the water. In order to express the degree of vacuum in terms of water suction let an absolute vacuum at sea level, where the mercury column measures 30 inches, be represented by a 34-foot suction even though that effervescence will occur at a much lower value, depending on the temperature of the water and the amount of occluded gas and air. At higher altitudes, the height corresponding to a perfect vacuum is of course correspondingly less, depending on the barometric pressure.

In a centrifugal pump, the point of lowest pressure lies below the water where the water first enters the rapidly revolving impellers; and in high-head, high-speed units the velocity of the water at this point may give rise to a velocity head measuring 12 or 14 feet at the



Boarding and bunkhouses in which are accommodated many of the workers at Keetley.

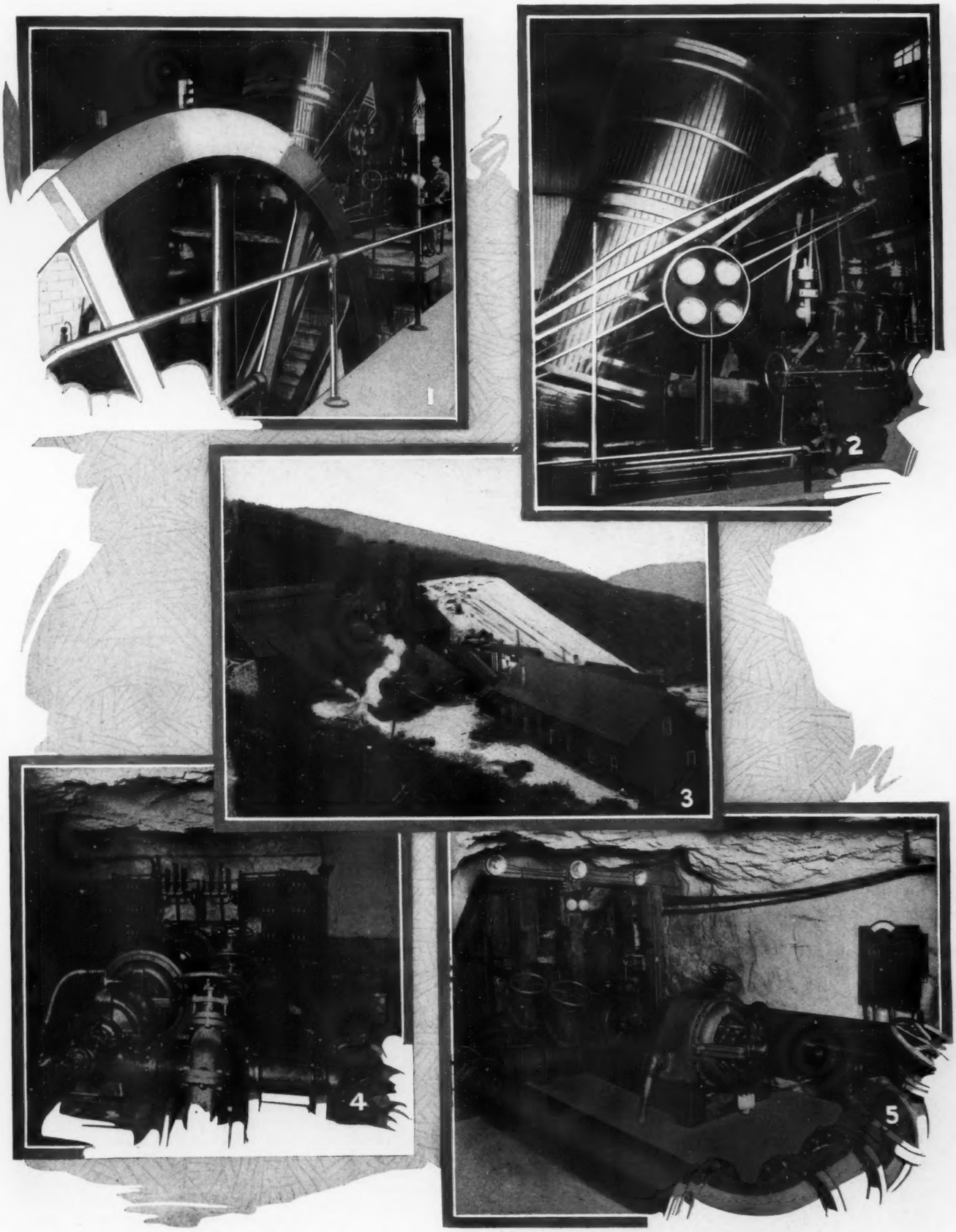


Fig. 1—Close-up of the 35-foot driving wheel, weighing 50 tons, of the old Cornish pump.
Fig. 2—Cylinder of the Cornish pump erected nearly 50 years ago.
Fig. 3—Old pumping plant of the Ontario Mine.
Figs. 4 and 5—New Cameron centrifugal pumps that have been installed on the 1,800-foot level of the Park-Utah Mine. These pumps cost but a fraction of the price paid for the old Cornish pump and handle nearly three times as much water.

pump's full capacity. This degree of vacuum at moderately high altitudes may be close to the point of effervescence; and any added suction head, caused by the height of the pump above the sump, will materially reduce the capacity of the pump. As any condition of effervescence at the inlet of the impeller prevents the rapidly revolving blades from gripping the water, the pump loses its water temporarily and becomes ineffective. Under such circumstances, centrifugal pumps have no margin left for sucking water up from a sump; and it is therefore of prime importance to so design a pumping plant that the water is positively delivered to the impellers.

To place the main pumps of a mine so that the water will flow by gravity to the impellers is impractical. Priming devices offer certain well-defined and well-known impediments. Both of these alternatives have been avoided at the Park-Utah by the use of small, low-head Byron-Jackson booster pumps of the vertical, deep-well type. These, set up below the water level of the sump, take the water by gravity and deliver it to the main pumps which, together with 4-speed motors, are installed 20 feet above the sump level.

The Park-Utah 28x38-foot shaft station, with its gunite walls and ceiling, is hewn in the footwall of a fissure 18 feet above the 1,800-foot level. With the station at this elevation above the underlying level there is eliminated the possibility of drowning out the pumps in case of a power interruption or the development of sudden rushes of water. Without the assistance of a bulkhead on the 1,800-foot level there is sufficient storage capacity for a 7-hour flow at 3,000 gallons a minute before the water could reach the level of the pumps. At present, the pumps are handling 2,350 gallons a minute.

The equipment consists of two independent units automatically controlled by 4-speed motors. Each unit is made up of a Byron-Jackson, 3,000-gallon, 40-foot head, vertical booster connected in series with a Cameron 8-inch centrifugal pump having a capacity of 2,700 gallons per minute under a 300-foot head. The water flows by gravity into the booster pump, from whence it is forced directly into the centrifugal pump on the station floor 18 feet above. No provision for the suction of water is required at any point. The driving motors for the boosters in the sump are also placed on the station floor to prevent the likelihood of their drowning out.

Each unit handles 2,700 gallons a minute. One of the units from the old pump station handles an additional 2,250 gallons a minute, giving the plant a capacity of about 5,000 gallons a minute with but one unit shut down. Leading from the station are two discharge pipes. One of these, of 14 inches, was used in the old Ontario Mine in the early "eighties:" the second pump column measures 10 inches in diameter. Enough valves and checks have been provided so that any one of the booster pumps can be made to serve any one of the high-pressure Cameron pumps.

The discharge pipes empty directly into a 16-inch wood-stave pipe that carries the water 1,500 feet to the Ontario No. 2 drain tunnel. Another distinctive feature of this installation is a flow-meter that shows the pumpman exactly how many gallons are being handled. On a recording chart on the upper level are also plotted the curves that indicate the number of gallons of water pumped during any period of the day.

Complete new runners and bearings for pumps are set up on the station floor alongside the operating units, thus permitting a quick change, in case of emergency, of the entire interior mechanism of the pumps. A new runner or impeller can be put in service in 20 minutes, which means safety and the possibility of pumping 5,000 gallons without interruption. As soon as a new shaft between the 1,500- and 1,800-foot level of the mine is completed, a concrete bulkhead will be installed on the 1,800-foot level, and this will feed water to the boosters under pressure and increase the efficiency.

During the first month the new plant was in use, operating as designed without priming or submersion, it has given 100 per cent. service. In addition, it has reduced the cost of power about one-third and has effected a like saving in labor.

Courtesy, Electrical World.

Attendant candling eggs which have just been cleaned by the sand blast, at the left.

SAND BLAST USED TO DRY-CLEAN EGGS

COMPRESSED air now serves to clean and incidentally to improve the quality of the eggs that go on the American breakfast table. Sand-blast outfits, using low-pressure air, are being successfully employed at three important producing centers by the Washington Co-operative Egg & Poultry Association for the purpose of cleansing eggs for the market. This method has been adopted in preference to the traditional one of washing the eggs with soap and water or with cleansing compounds. A twofold advantage is gained thereby: the work is accomplished at a saving in time and money, and the eggs are turned out in a superior condition. It was discovered, as a result of experiments, that washing tended to soften and to seal the pores of the shells, thus hastening the deterioration of the eggs.

The sand-blasting device consists of a sheet-metal housing in which a near vacuum is maintained by means of an exhaust fan. Fine white sand, contained in a hopper at the top, is carried downward through tubes to nozzles placed just above an electrically operated endless conveyor carrying the eggs and, at the same time, turning them over and over on rubber rollers. To prevent breakage, the sand is directed at the eggs in a fine spray. The dust is removed from the sand by suction and carried outside the building while the sand falls into a pit, whence it is fed back into the hopper for re-use.

After they have been cleaned in this fashion, the eggs are passed over a battery of powerful electric lights, where an attendant candles them. They are then taken from the conveyor by hand and packed for shipment. The sand-blasting machine has a daily capacity of 300 cases of eggs.

This process of dry-cleaning not only costs less than the older method of washing eggs, but it simplifies both their candling and grading. As eggs so handled are in better condition and more readily resist deterioration they command a better price—from one to four cents a dozen—and are given a higher storage rating.

Quarrying and Finishing Pulpstone

By J. N. PETERSON

PULPSTONE is the name given to a sandstone having certain qualities that make it adaptable for use in paper mills for grinding the wood to a pulp. It is sandstone of this character that is quarried on the property of the Smallwood Stone Company located in Empire, Ohio. The purpose of this article is to describe the ways and means employed there to work the stone ledge and to support the overburden, to show the various steps in the process used to finish the stone, and to bring out the part played by compressed air in quarrying and in dressing the stone.

The problem that confronted the producers at Empire was to secure the maximum amount of workable pulpstone from a horizontal ledge having a thickness of about 60 feet—the stone being covered with an overburden of sandstone, limestone, shale, and dirt varying in depth from 100 to 1,000 feet. This problem has been solved by working the ledge by the room-and-pillar system. The rooms, when finished, are approximately 24 feet wide, 70 feet deep, and 80 feet long. The pillars left to support the overburden are of about the same size as the rooms. Additional support for the back is obtained by the use of 12-inch steel I-beams, the ends of which are fitted into notches in the stone and concreted in place.

A room is started by driving a heading about 7 feet high over the top of the pulpstone, thus stripping it and providing adequate space for the operation of an electric-air channeler. A BCR-430 "Jackhamer," on a shell and tripod mounting, is employed to do the drilling in this heading. A 6-hole "V" cut is first drilled and shot. Then holes are drilled on each side so that they will break to the free face made by the "V" cut.

Both 7-inch electric-air track channelers and "Jackhamers" are utilized to cut the pulpstone into blocks of approximately 12x12x12 feet—the channelers cutting the sides and ends and the "Jackhamers" drilling horizontal holes along the bottom. These holes are creased and shot with a slow-acting explosive, thus breaking the blocks loose from the ledge. The large cubes are next cut as closely as possible into the various shapes and sizes desired in the finished article. This work is done by the plug-and-feather method. With the underground operations completed, derricks raise the heavy stones to the surface where they must undergo exterior rough shaping and finishing.

Pneumatic chipping hammers of the 3-R type are used to rough shape the pulpstone which is given its final dressing—that is, made cylindrical in form—on a lathe. But before this work can be undertaken it is necessary to cut

Left—Illustrating method employed to support the overburden at the quarry of the Smallwood Stone Company. Top—An electric-air channeler at work underground in getting out pulpstone in the quarry at Empire, Ohio. Bottom—Close-up of a 7-inch electric-air channeler used by the Smallwood Stone Company.

a hole through the center of the stone so that it can be mounted on the lathe shaft. This axis is about 4x4 inches square, and is cut by first drilling a number of holes at the desired point with a "Jackhamer" and then breaking away the material between these holes by the aid of the chipping hammers already referred to. After the pulpstone comes from the lathe, perfectly smooth and cylindrical, the hole is chipped to the size and the shape specified by the ultimate user to suit his mountings. Usually the hole is circular and funnelled at both ends.

During a busy season at the Empire quarry, two electric-air channelers, and a proportionate number of "Jackhamers" and chipping hammers are in continuous service throughout the working day producing pulpstones for the papermaker. A 14x12-inch I-R single-stage compressor furnishes the air necessary to operate this pneumatic equipment.

The City of Los Angeles is building numerous pedestrian subways for the safety of the general public. Eleven of these subways have been completed, seven are under construction, and eight more are being planned. The average contract price to date has been $6,600 per subway—not including the cost of rights of way, electrical wiring, etc.

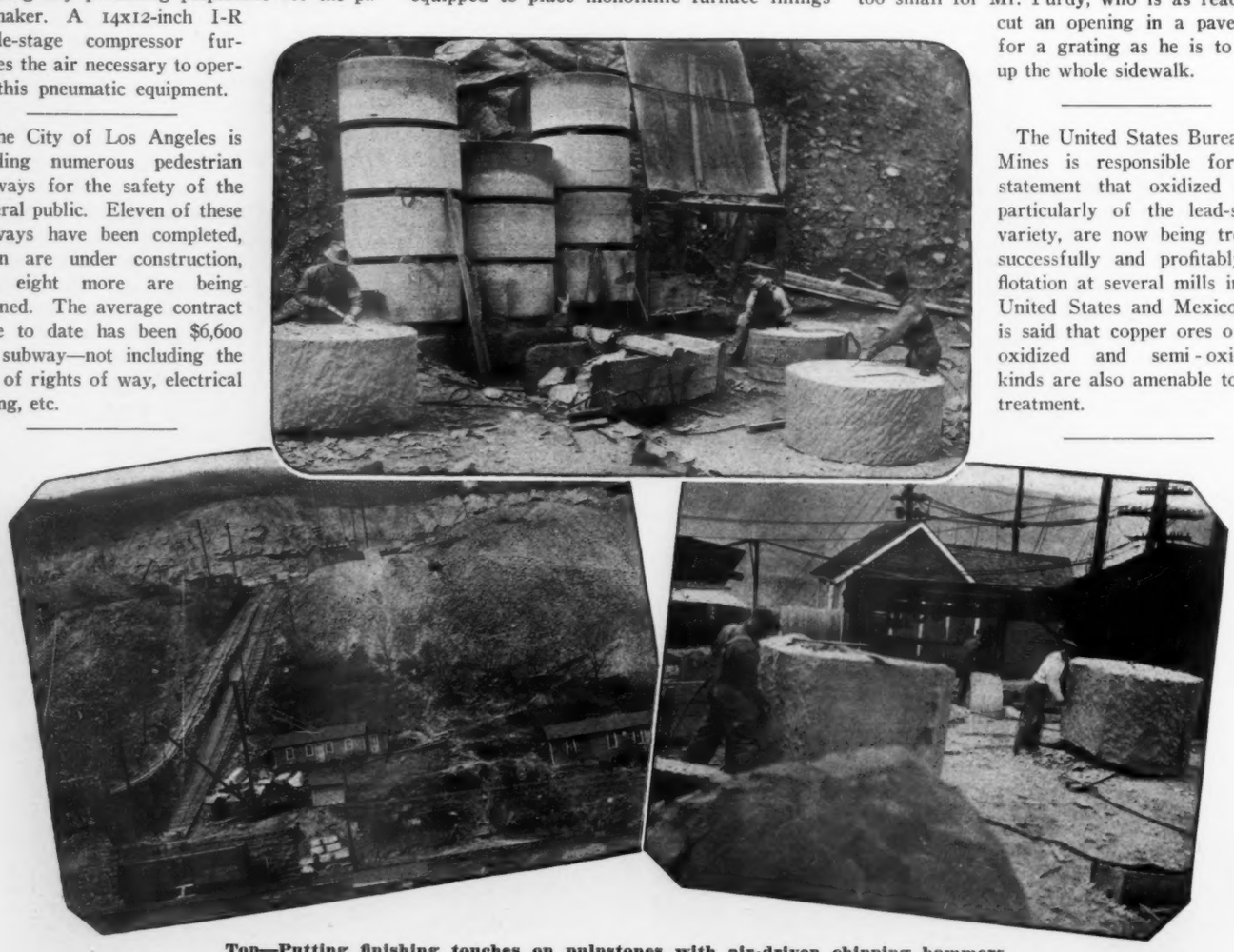
PURDY DOES IT WITH COMPRESSED AIR

"DO It With Compressed Air." This is the motto of Milton A. Purdy, of San Francisco, who has mounted an Ingersoll-Rand air compressor on a specially equipped Ford truck. Over the compressed-air outfit there is a signboard, which reads as follows: "This outfit for rent. Quickly portable pneumatic power and cutting equipment. Nothing stops us. We cut through anything—anytime —anywhere. Concrete—brick—steel."

And this is no idle boast, for this progressive young man is prepared to do pneumatic calking, chipping, cutting, drilling, riveting, and spray painting. He is also equipped to place monolithic furnace linings with centrifugal pumping equipment. Especially adapted for drilling foundation bolt holes; for demolishing old foundations; for cutting openings for doors, windows, etc., in brick or concrete; for work in connection with bridges and other steel structures; for tearing up pavements to reach sewers, gas mains, etc."

The value of such an independent 1-man outfit cannot be overestimated. There are hundreds of small jobs that do not properly come within the scope of a contractor, likely to possess a portable, that nevertheless can be done better, within less time, and at a lower cost by means of pneumatic equipment than by the use of hand methods. No job is too small for Mr. Purdy, who is as ready to cut an opening in a pavement for a grating as he is to tear up the whole sidewalk.

The United States Bureau of Mines is responsible for the statement that oxidized ores, particularly of the lead-silver variety, are now being treated successfully and profitably by flotation at several mills in the United States and Mexico. It is said that copper ores of the oxidized and semi-oxidized kinds are also amenable to this treatment.



Top—Putting finishing touches on pulpstones with air-driven chipping hammers. Left—General view of the quarry at Empire, Ohio, of the Smallwood Stone Company. Right—Rough forming pulpstones with air-driven chippers.

It is pointed out by the Chamber of Commerce of the United States that if some of our cities continue to spread as much in the next 40 years as they have in the past 20, the United States would not be large enough to accommodate more than seven such communities. For example, Los Angeles has shown an increase in area of 815 per cent. since 1923, when that city covered 250,651 acres. At the same rate of growth, that progressive community would exceed in size the entire state of California at the end of ten years.

Purdy believes in advertising. He has had blotters made bearing a picture of his portable compressor and the following statement: "Our compressed-air power unit is fully provided with air tools of all sorts, including asphalt cutters, concrete paving breakers, Jackhamers for drilling concrete, rock, etc., as well as by compressed air and to coat furnace walls by the air-spray method. If there is anything that can be done by means of air that young Purdy is not ready to undertake with his outfit we have yet to learn of it.

During October, 1926, public-utility plants of the United States produced 6,499,196,000 kilowatt-hours of electric energy, a new high record. Of that total, 4,339,920,000 kilowatt-hours was produced by fuel-burning plants and 2,159,276,000 kilowatt-hours came from water-power plants. The average output per day was 211,600,000 kilowatt-hours. Entering into the production were 3,680,780 short tons of coal, 914,424 barrels of crude oil, and 4,948,558,000 cubic feet of natural gas.

Cheat Haven Hydro-Electric Project

Compressed Air Was Used to Advantage in Completing This Unit of the West Penn System

By ALLEN S. PARK

COMPRESSED air played various important roles in the construction of the new 64,000-kilowatt hydro-electric plant of the West Virginia Power & Transmission Company, at Cheat Haven, Pa. This project, which was completed in record time, is the first water-power development of the West Penn system, in which it is incorporated.

A concrete dam provides an equalized flow of water through the creation of a reservoir 13 miles long, varying in width from ¼ mile to 1½ miles, and having a high-water-line capacity of 23,600,000 gallons. The dam is 1,110 feet long, 110 feet high, and 140 feet wide at the base. The spillway section is 624 feet in length and carries 26 Taintor gates, each of which is 21 feet high and 17 feet long. From the dam, penstocks deliver the water under an 80-foot head to four 16,000-kilowatt turbines and generators. The plant is tied in with the general West Penn system by means of a high-voltage transmission line carried on steel standards.

Although the project was not authorized until the spring of 1925, progress was such that water began flowing over the spillway on December 23 of that year. The first generating unit was in operation the following June, and the entire plant was functioning by the fall of 1926.

Construction called for the excavation of 48,000 cubic yards of shale at the dam site. Materials entering into the concrete work included 80,000 tons of sand, 85,000 tons of gravel, 85,000 tons of stone, and 175,000 barrels of cement. To facilitate the handling of materials and equipment, approximately 10,000 feet of standard-gage railroad track was laid in and about the site—connection with the Baltimore & Ohio being made at Cheat Haven. As a part of the preliminary operations, a large camp was built to house the workers as well as a number of cottages for the engineers, foremen, and their respective families.

The Cheat Haven hydro-electric project is the outcome of a plan outlined some fifteen years ago. Construction was originally begun in 1912, but work was suspended the year following. A 300-foot section of the dam and foundations for the power house completed at that time were incorporated in the new undertaking. But before that part of the dam could be made available, an average of 4 feet of old concrete had to be chipped from its downstream face. This was done with "busters" operated by compressed air.

The new construction was started on the west side of the river—a cofferdam being erected to divert the flow of the stream. While the eastern and central sections of the dam were being placed, the water was handled through tunnels in the western end of the structure. These tunnels were later concreted. Despite the occurrence of two severe floods during the working period, serious damage was prevented through the prompt reinforcement of the protecting structures.

The narrowness of the valley necessitated locating the concrete-mixing plant a quarter-mile below the dam site. This plant consisted of two 2-cubic-yard tilting-type mixers, each of which was capable of producing 20 batches an hour. To expedite operations, day and night shifts were employed. By December 1, 1925, five months after the pouring of concrete was started, 121,000 cubic yards had been placed in the forms. This is claimed to be a record for work of this kind. The maximum pouring for one day reached 2,176 cubic yards.

Above the mixers was a 5-compartment bin: two sections for stone, two for gravel, and one for sand. Each class of material was measured into hoppers by a standard batcher having air-controlled gates. Cement was delivered to the charging floor by a belt conveyor running from an adjacent depot having a storage capacity of 5,000 barrels. From the mixing plant the concrete was dumped into 2-yard buckets on flat cars. These were moved to the point of use by small engines. Derricks lifted the buckets into position for dumping into the forms.

Because of the great demand for concrete materials during the peak period of construction, the project called for expert administration of transportation. As local mills were unable to supply cement in sufficient quantities, trains made up of as high as 30 cars of 200 barrels each were run from distant plants. All told, some 150,000 cubic yards of concrete were required for the dam and the power house. Gravel was used as a coarse aggregate in the

Photos. Geo. A. Croft, Uniontown, Pa.

Left—Near view of cofferdam No. 1 on the west side of the Cheat River, with earlier dam section on the opposite side of the stream.
Right—Upstream face of the dam, as the structure appeared at a later date from the west bank of the river.

mix for the main portion of the dam, while the concrete for the exposed surfaces was made with crushed limestone.

The power station, situated on the east side of the dam, is a steel-and-brick structure 167 feet long, 109 feet wide, and 100 feet high. The turbines occupy the lower floor. The generators are on the second floor, with controls and switching equipment on a mezzanine above. A 100-ton crane is provided for handling machinery within the plant. The transformer banks are outside, on the downstream side of the building.

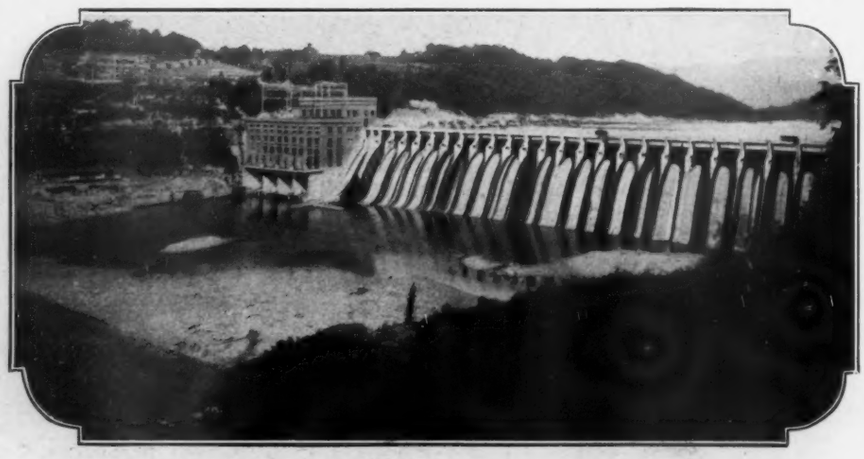
How the completed undertaking appears from the east bank.

One novel use was made of compressed air during the construction period in connection with the emptying of sand from hopper-bottomed cars in which it was delivered to the site. To facilitate the movement of the sand, which has a tendency to pack, streams of air at from 90 to 95 pounds pressure were introduced into the mass through ¾-inch pipes carrying ¼-inch nozzles. By thrusting these pipes into the mass, it was possible for workmen at either end of a car to cause the sand to flow without stoppage and to eliminate hand labor, such as is commonly called for in unloading material of this kind. This method was employed by Superintendent H. L. Myer as a result of experience previously with concrete dumped successfully in a similar fashion.

Air-driven rock drills were used in the work of excavating—as many as 14 being employed much of the time. A "Leyner" No. 50 sharpener was used to condition the drill steels. Five air hoists were employed variously on the job: a battery of three furnishing power to draglines employed in reclaiming materials from storage piles. In the blacksmith shop compressed air operated an 800-lb. hammer and an oil forge. Compressed air was also utilized for cleaning forms and for a number of other purposes in the machine shops. The air was supplied by two compressors having a combined capacity of 2,150 cubic feet per minute.

The Cheat Haven plant is used to handle peak loads on the West Virginia Power & Transmission Company system—the power being required principally for industrial purposes. The cost of the undertaking, including plant equipment, was $4,500,000. Through the construction of additional plants along the same drainage basin, it is expected that the Cheat River can ultimately be counted upon to produce 500,000 kilowatts of electrical energy.

The Cheat Haven project was designed and constructed by the engineering firm of Sanderson & Porter, of New York City, in collaboration with the firm of Mead & Scheidenhelm, consulting engineers, and the executive officers and engineers of the West Penn system. The work was in general charge of W. E. Hamilton, construction manager for Sanderson & Porter, and H. L. Myer, of the same firm, directed the work as resident superintendent.



Finished dam and power house as seen from the west bank of the Cheat River.

SURFACE HARDENING STEEL BY NEW PROCESS

A NEW surface-hardened special steel, made by a process evolved by Dr. Fry of the research laboratories of Messrs. Friederich Krupp, of Essen, Germany, is finding a field of usefulness in the automotive and aviation industries of Europe. The material is especially suitable for parts requiring a highly hardened metal. Ring gears, crank shafts, cam shafts, and other parts—which are subjected to maximum punishment—are being made of this material for several high-priced foreign cars. License to manufacture the steel in this country under the trade name "Nitralloy" has been secured by one of the large American steel companies.

The process of hardening, termed nitration, is based on diffusion—nitrogen being allowed to penetrate the surface. Briefly stated, it consists of heating the steel to a temperature not exceeding 1,025°F. in the presence of ammonia gas. Because the hardening process is carried out at a relatively low temperature, the necessity of heat treatment for grain refinement and ultimate hardness is eliminated. It is this subsequent heat treatment, it is contended, that impairs the hardness of case-hardened steels through expansion, deformation, or actual breakage in the final quenching operation. As there is no warping or deformation attending the nitration process, articles can be finished and in some cases even polished before hardening.

Tests conducted at the Krupp works indicate that the highest degree of hardness penetrates to a depth of approximately two-tenths of a millimeter, from which point it diminishes gradually. It is claimed that the surface of nitrated steel will retain its hardness in any heat up to 1,025°F.

FERTILIZING WITH LOCUSTS

HORDES of locusts which have descended upon Argentina in recent years are being utilized as a raw material in the manufacture of fertilizers, according to the *Oil Miller and Cotton Ginner*. Discovering that the locust carcasses contain appreciable percentages of nitrogen, phosphoric acid, and potash, a firm of fertilizer manufacturers in England informed the government of Argentina that it was prepared to purchase large quantities of those destructive insects. Publicity was given this information, and a novel industry was thereby born.

Natives collect the locusts by driving them into trenches and smothering them with earth. The raw product commands a price delivered at Santa Fe, Argentina, of approximately $16 a ton. It is claimed that this price allows a profit of over $5 a ton to the collectors. Thus, again, we find that every bane is sooner or later a blessing.

Story of The Portland Gold Mine

New Era of Production Promised in Cripple Creek Through the Success Achieved in the Working of this Property

PART III

By C. H. VIVIAN

ONE phase of the Portland operations that is particularly worthy of note is the cheap handling of mill dirt through the Independence Shaft. This is effected by a haulageway drift which is on the 700-foot level in the Independence and on the 900-foot level in the Portland No. 2. The ore comes principally from the old Captain stopes in the upper workings of the Portland.

The material, which is caved, is loaded from chutes—controlled by air-lift gates—into 4-ton steel cars that are hauled approximately 2,000 feet by electric locomotive. This 4-ton, trolley-type unit operates at a maximum speed of 8 miles an hour and has a haulage capacity of 70 tons. An 18-inch-gage track is used.

At the Independence Shaft the cars are dumped into a loading pocket, fitted with air-lift gates, for filling the skips. The rock is hoisted to the surface and passed over grizzlies, which allow about one-third of the ore to pass through and reject the remainder. The fine material is conveyed direct to the adjacent mill in mine cars—the rejected or waste material being carried to dumps.

The cost of hoisting 94,430 tons by this method in 1925 averaged 33.2 cents a ton, while the cost of the dirt at the mill—allowing for the rejection of approximately two-thirds of the tonnage hoisted—was 96 cents a ton. There are millions of tons of material in the former workings of the Portland and the Independence that can be handled through this haulageway; and, because of the economy effected, it is possible to treat an exceedingly low grade of mill dirt at a profit.

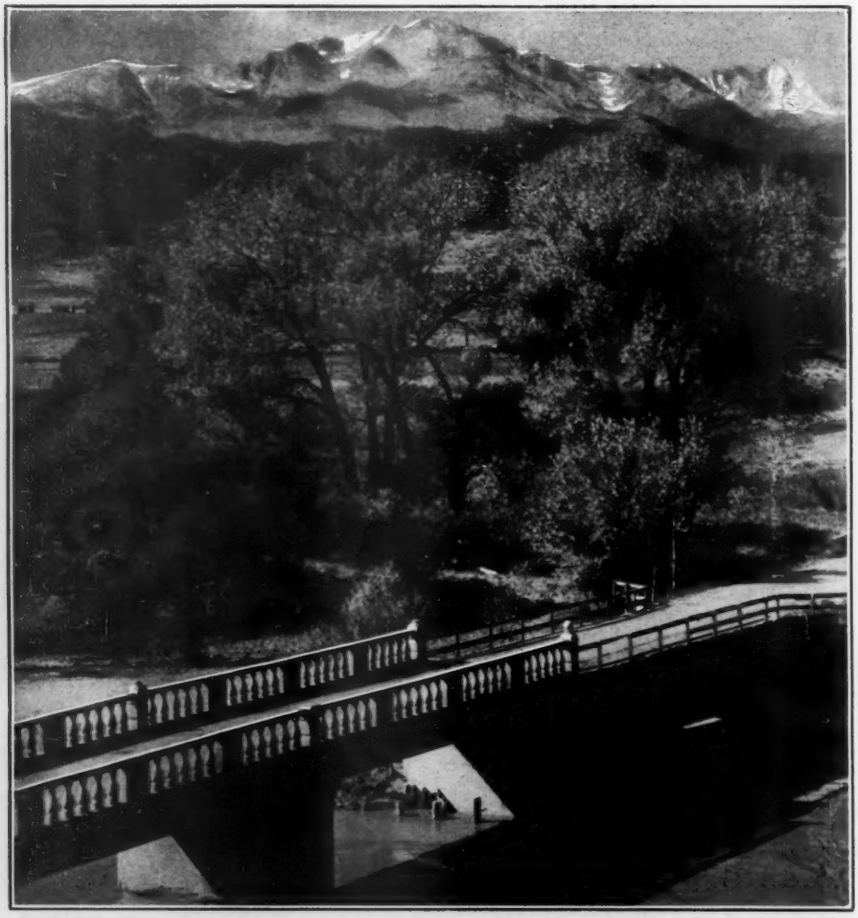
One of the principal prospecting operations now in progress is the driving of a drift from the 2,100-foot level of the Portland No. 2 Shaft southward into Independence ground. This drift, which will cut the Independence workings 329 feet below the shaft sump, is now 500 feet across the boundary in Independence territory, but so far has cut no veins of commercial importance. When a point opposite the Independence Shaft is reached, crosscuts will be started searching for the continuation of veins that were worked profitably on the higher levels of the mine. If new deposits are found in the Independence, the shaft will be sunk to the level of the drift.

Milling has been a part of the Portland operations since 1900, when the company constructed

Left—At work on the 2,900-foot level with CCW-11 stopers.

Right—A "Leyner" drill sharpener in the blacksmith shop of the Portland Mine.

Bottom—An N-72 drifter at work on the 2,700-foot level in Shaft No. 2.



Courtesy, Pike's Peak News Bureau.

Pike's Peak as seen from Colorado Springs on the road to Cripple Creek.

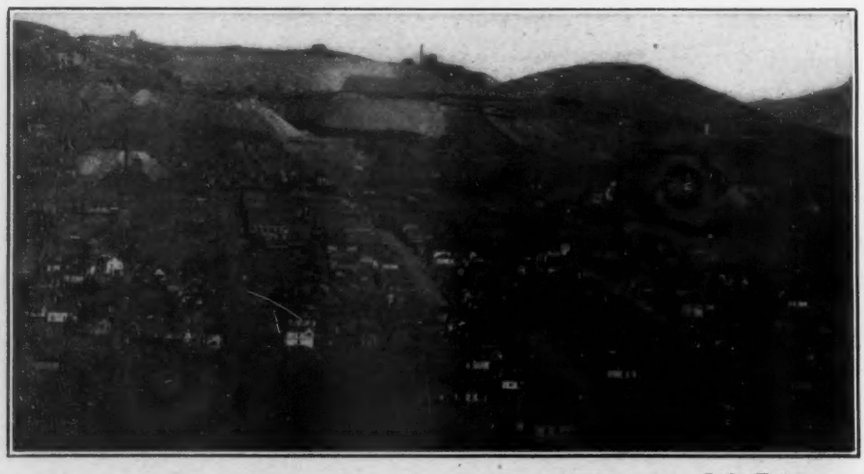
a chlorination mill at Colorado Springs that is capable of handling 400 tons daily. In 1907, when it had been conclusively demonstrated that cyanidation was better adapted to the treatment of Cripple Creek ores, a cyanide annex was built. This not only treated the material coming direct from the mine but also worked over at a profit most of the waste from the chlorination plant.

In 1910 a cyanide mill was constructed near the summit of Battle Mountain and adjacent to the No. 3 Portland Shaft which was then in use. It was at this gold-concentration mill that the company's experts developed what came to be called the Portland process. The results obtained thereby, though improved upon since, were at the time considerably in advance of any previously recorded in the art. In 1911 a recovery was effected of approximately 78 per cent. of the contained values, and the cost of treatment was materially reduced. This was then considered a metallurgical triumph and paved the way to substantial profits from the discarded waste rock. In that year the plant netted $128,000. In 1912 it treated 500 tons of material daily, making a profit of $1.17 a ton on an input averaging $3.15 to the ton. Both the capacity and efficiency of this plant were continually increased; and in the years following it handled immense tonnages. Huge volumes of rock already on the dumps were profitably treated, while the amount of waste material from the mine was cut to a fraction of that previously discarded.

In 1915 the Independence mill was acquired by purchase of that property. This mill was enlarged several times, and was finally equipped in 1918 to handle 1,500 tons daily. The Colorado Springs and Battle Mountain mills were then closed—the latter being dismantled and part of the equipment moved to the Independence plant. Since then modifications and improvements have been made from time to time and a great deal of experimentation has been done with flotation, which has been practiced now and then on a small scale and discarded. Superintendent John M. Tippett, who has been with the mill department of the company for nearly 25 years, is continuing his laboratory work with this process and predicts that some day it will be perfected for the treatment of Cripple Creek ores. During 1926, one 16-cell flotation machine was installed and another just like it is now being placed. An addition is also being constructed to the present plant for the purpose of treating all flotation concentrates in the raw state without roasting. The crux of the problem lies in the infinitely small amount of gold—as compared with lead, zinc, and copper—contained in the ores now being treated by flotation. The baser metals are present in only negligible quantities in Cripple Creek ores. And right here it might be remarked that in the case of all processes, methods, etc., developed under Mr. Tippett's direction, not only have such processes and methods been worked out in the laboratory but they have been fully tested through the agency of pilot plants before appreciable sums of money have been spent in designing commercially practicable mills.

It is significant that of the 50 or 60 mills erected during the life of Cripple Creek but two survive: the Independence, of the Portland Company, and the Golden Cycle at Colorado Springs. Both make use of cyanide processes, the Independence mill differing from the last-named primarily in that it treats the raw ore without roasting. While roasting effects greater economies, the saving is not sufficient to warrant its installation by the Portland Company because of the low average value of the material handled there. The Independence mill has a normal input of 500 to 600 tons a day on a 2-shift or 16-hour working basis. It utilizes straight cyanidation and concentration. Figures for 1925 show that slightly over 90 per cent. of the values was recovered from mill dirt averaging $4.82 to the ton.

Storage bins are provided having a capacity of 3,000 tons. After being pulverized by pass-



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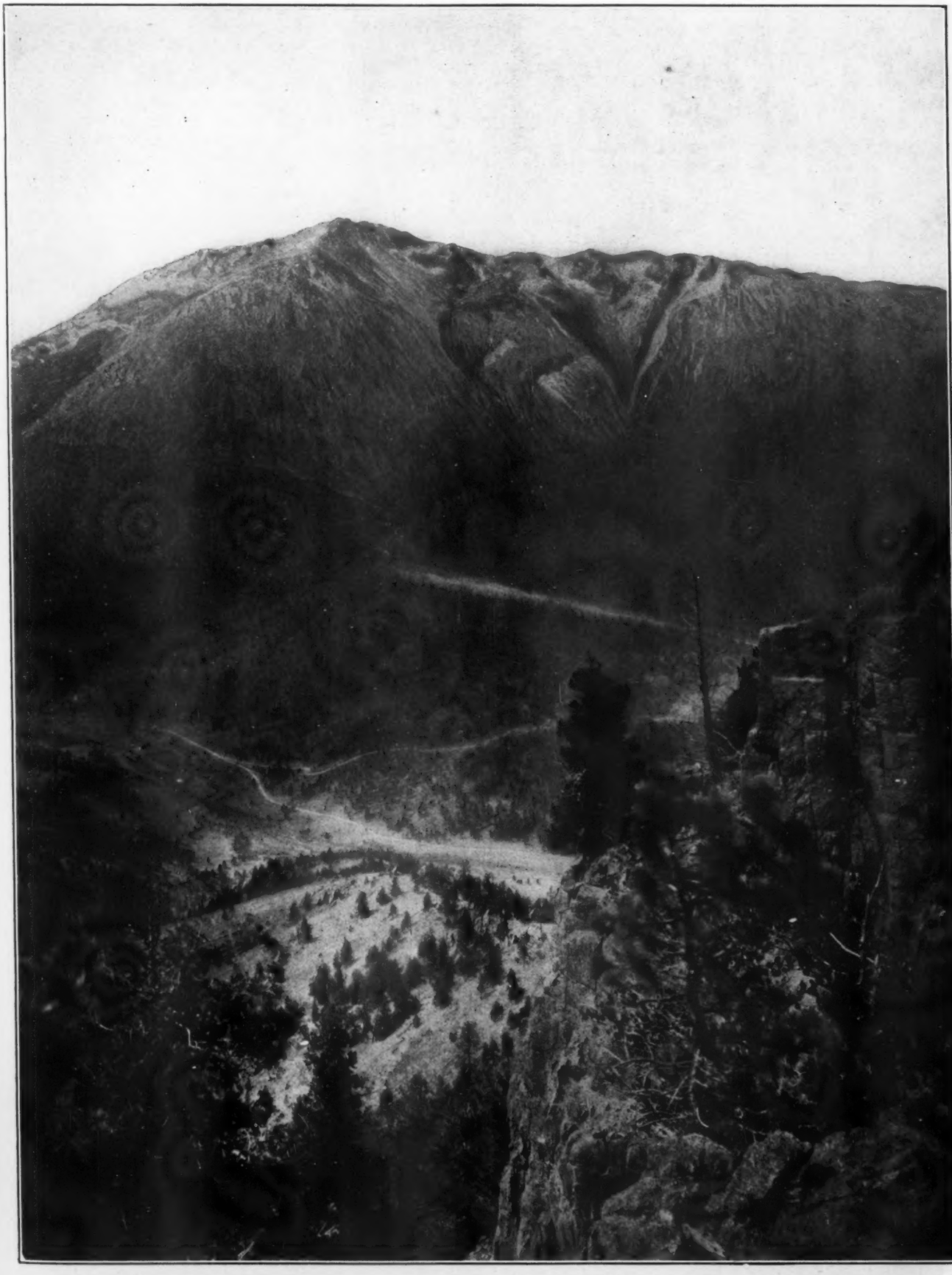
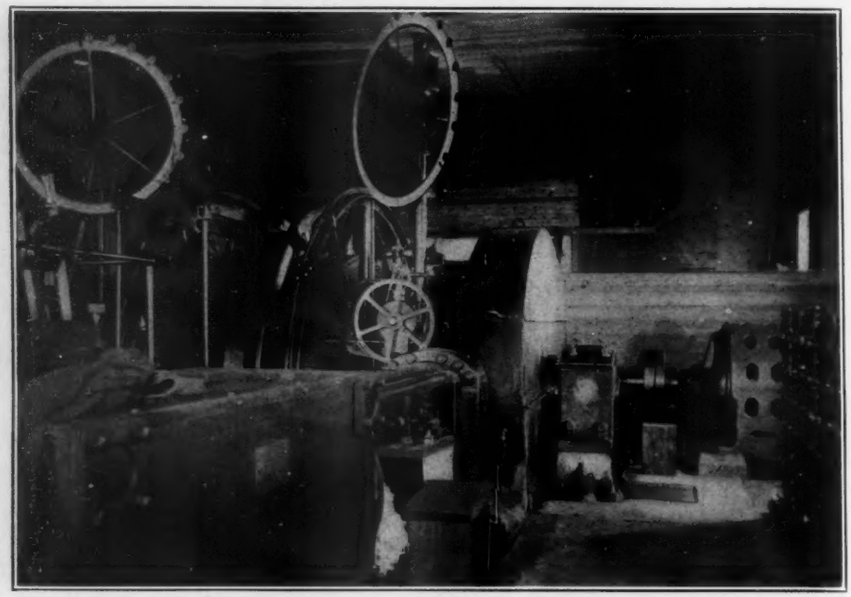
Victor, a city of mines, with the extensive workings of the Portland Gold Mining Company in the distance.



Pike's Peak as it appears from Ute Pass. The road in the valley is the main highway between Colorado Springs and Cripple Creek.



Electric hoist at Independence Shaft, which is 1,430 feet deep.

ing through Gates crushers, 72-inch Allis-Chalmers rolls, and Chilean mills, the material is classified in an Akin classifier—the fines going to a plant below and the coarse aggregate to ball mills, of which there are six having a closed circuit. The flow is then directed to the concentrating tables, 31 roughers and 11 finishers. Of the concentrates from these tables 1 per cent. is sent to the Golden Cycle mill for treatment. The tailings from the finishers return to the ball mills and are ground until 80 per cent. of the material will pass through a —200-mesh screen. Next, the tailings are treated in three agitators, 35 feet in diameter, passing from one to another in series. The overflow from the last agitator goes again into the main system and over the tables—any of the remaining concentrates being caught on the roughers.

The resulting slimes are pumped to a distributor which, in turn, discharges them into Dorr thickeners. The overflow from these thickeners passes into the general mill system and serves as dressing water needed in the mills and on the tables, while the underflow—which is of about 1.35 specific gravity—is fed to six Dorr agitators where it remains from 72 to 96 hours. From Merrill filter presses the gold solution is conveyed to a so-called gold tank, where the metal is precipitated with zinc dust. The tailings are handled by 210-foot lift pumps, and are discharged by way of a ridge into ponds created in a valley approximately a mile from the mill.

A feature of the mill clean-up is the inclusion of the high-grade ore from the mine. The high-grade, averaging several dollars in gold content to the pound, is hand picked from the ore in the stopes by specially detailed men, sacked, and placed in a vault in the company's office. From there the precious metal is taken to the mill at suitable periods.

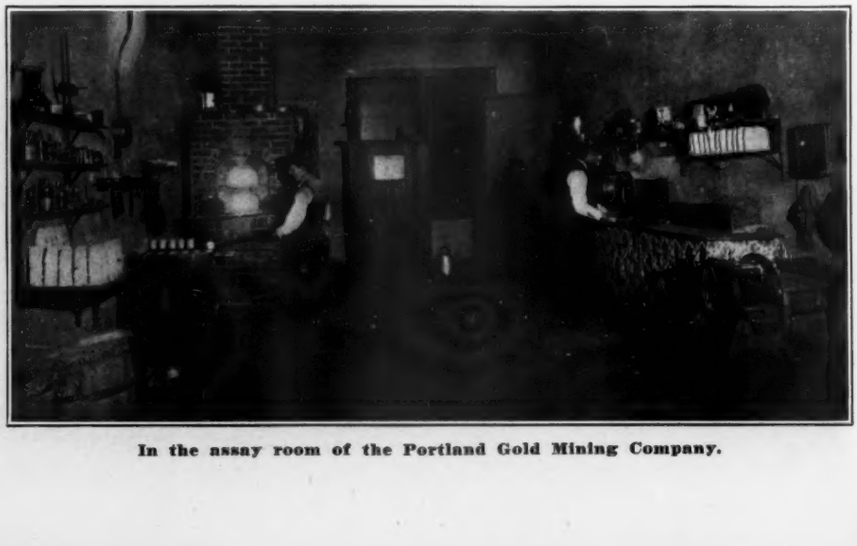
The precipitate in the gold tank at the mill is removed every 10 or 15 days for melting. After being crushed to 14-mesh fineness and roasted, the high-grade is mixed with the precipitate in the proportion of from 50 to 75 pounds of ore to each 100 pounds of precipitate. This is then bricked and melted in a 2-barrel Rockwell furnace, thus obviating the necessity of adding silica for fluxing purposes. Fluorspar, which formerly was purchased in carload lots, is now a product of the mine, being found in abundance in close relation with the ores. The only fluxing material that is now bought is sodium carbonate. In addition to handling the ore mined by the company, the mill also treats some custom ore and that produced by its own lessees.

The Portland, in common with other mines of the region, enjoys a high class of labor through the maintenance of a card system which was introduced in 1903. The mine owners have an association with offices in both Cripple Creek and Victor. All applicants for work in the mines must first secure a card from one of these offices; and no man is approved until it is ascertained that he is desirable. This is done to prevent a recurrence of the memorable strike of 1903-'04, when bloodshed and riotry prevailed there upon a wholesale scale. The working force in the mines, almost without exception, is American.

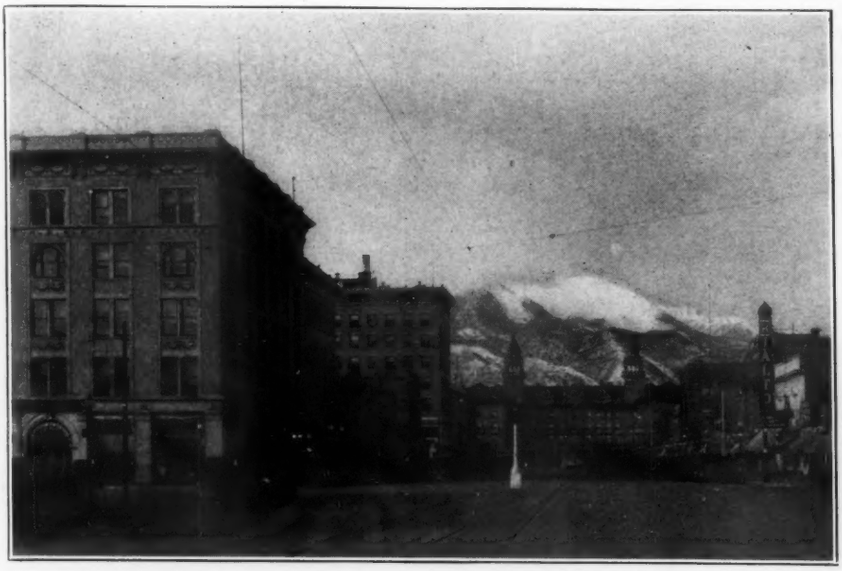
As previously mentioned, the safety and the welfare of its workers have always influenced the management of the Portland Gold Mining Company. For their comfort has been provided a spacious, steam-heated change room, with 180 steel lockers, shower baths, hot and cold water, etc. An emergency hospital is on the property; and gas masks are held in readiness in case of emergency. A first-aid team, led by Ray B. Emens, mine engineer, has been recruited from among the miners. A company store, in charge of F. A. Hamilton, carries $30,000 worth of stock at the mine and the same amount at the mill. This not only includes supplies and materials needed at the mine but also clothing, etc., for the miners.

One of the things that has made for the success that has attended the activities of the Portland is the fact that ever since its inception the directing personnel of the organization has undergone few changes. This has made for stability and has generally assured accord on all broad matters of policy. From the date the present company was organized until 1908, James F. Burns occupied the president's chair. For several years thereafter the company was under the directorship of Frank Peck. In 1913 Mr. Irving Howbert, present chief executive, assumed the helm and has served continuously ever since. Furthermore, all the company's presidents have been mining men, with a miner's conceptions and viewpoints. William Lennox is vice-president; W. T. Hair, secretary and treasurer; and the board of directors is composed of Irving Howbert, W. T. Chinn, William Lennox, James B. Grant, and Joseph W. Ady, Jr., who has held the post of managing director since 1923. It has been under Mr. Ady's management that the company was brought back to an earning basis.

Detailed supervision of mine operations is in the hands of Superintendent Fred Jones, who came to the Portland in 1903 when the deepest workings were 1,000 feet below the surface. After serving in minor capacities he became mine engineer, and was promoted to



In the assay room of the Portland Gold Mining Company.



Courtesy, Pike's Peak News Bureau.

Pike's Peak Avenue, Colorado Springs, with the Mining Exchange Building, at the left, in which are located the offices of the Portland Gold Mining Company.

superintendent in 1910. His familiarity with the property and his accurate analyses of conditions as regards ore occurrence have proved big factors in crowning the operations in deep ground with success. It was his reports and recommendations that influenced the directors to continue the probing of the underlying zones which, in the case of other properties, had been consigned to the limbo of futility.

Working directly under Superintendent Jones is Ray B. Emens, the mine engineer, who is assisted by Willis Hills. Engineering records of work on the Portland property have been kept up to date; and it is possible by the aid of a glass model to trace the workings on every level. E. H. Nate, of Colorado Springs, is the company's consulting engineer; James Walsh, a veteran miner of the district, serves as mine foreman; and X. A. Martin is master mechanic.

The present operating schedule calls for two shifts: the day shift, which goes on at 7.30 in the morning and comes off at 4 o'clock in the afternoon, and the night shift which starts at 5.30 p. m., allowing an appreciable interval for the clearing of smoke and gas from the mine following blasting. The average working force at the mine and the mill numbers 200.

The Portland maintains a very liberal policy towards lessees, adhering to the "split-check" system which originated in the Cripple Creek district. Under this arrangement, the company furnishes everything to the tributers except drilling machines and air hose, and hoists their ore to the surface. Returns are divided equally. Moreover, lessees are accorded the privilege of having their ore milled either in the Portland plant or at the Golden Cycle mill.

Up to January 1, 1926, the Portland's underground workings had an aggregate length of 68 miles and 3,599 feet, divided as follows: drifts, 161,731 feet; crosscuts, 148,125 feet; raises, 32,297 feet; winzes, 6,668 feet; shafts, 13,818 feet. The Independence workings totaled 17 miles and 11,917 feet, of which all but a small stretch was the result of work done by former owners.

The ore production from April 1, 1894, to January 1, 1926, amounted to 1,802,694 tons, having a total value of $47,571,667 or an average per-ton value of $26.38. In that period the mills of the company had treated 3,745,583 tons of material worth $10,592,149. The banner year for ore production was 1903, when 90,244 tons were mined valued at $2,608,993, while in 1918 something like 522,756 tons of mill dirt—a daily average of 1,450 tons—was treated. This was a record performance; and the material gave a return of $1,071,924.

Current conditions at the mine point to a steadily increasing scale of operations, particularly in the raising and the treating of mill dirt. Last spring, new skips were placed in the Independence Shaft to augment its hoisting capacity—the electric haulage equipment on the 700-foot level serving as the principal feeder. This shaft is now capable of raising 1,000 tons daily.

Parallel to the No. 1 east vein, which now furnishes the bulk of the high-grade ore from the No. 2 Shaft, is another well-defined vein known as the No. 2 east. While this vein has revealed no ore of shipping grade, it promises to produce a big tonnage of mill dirt.

Platitudes and aphorisms have little place in the mining industry. And yet, as the accomplishments of the Portland Gold Mining Company are reviewed, one cannot help but recall that little cardboard sign in the engineering offices of that company bearing the inscription: "The pessimist lacks practical information, intelligent application, and common courage."

AIR LINE TAPPED WHILE UNDER PRESSURE

A METHOD of drilling and tapping a compressed-air line while under pressure, as reported by a correspondent to the *Southern Power Journal,* might interest some of our readers. A lever was made by passing the end of a wooden bar beneath a rope loop around the pipe, which was of 6-inch diameter. The air-operated drill employed was held in place by means of this device.

Before drilling was started, a nut of the proper size to fit over the end of the pipe tap and a ratchet wrench to fit the nut were placed handy. As soon as the hole was drilled, the drill was removed and the ratchet wrench with the tap in it was put over the hole under the lever, thus making it possible to tap the line while under pressure.

Courtesy, Pike's Peak News Bureau.

Tunnel on the Corley Mountain Highway running from Colorado Springs to Cripple Creek.

South Africa Depends on Compressed Air To Help Build Necessary Good Roads

GOOD roads are not to be classed as an expenditure, rather are they to be considered as probably the finest investment that any country can make. In South Africa, a country of vast spaces with widely separated centers, there is a crying demand for means of rapid, safe, and economic transport, especially in districts not served by the railway, and, indeed, generally as an auxiliary to that service. "We Want Good Roads" is therefore no parrot cry. It is not the slogan of a handful of racing motorists, but is, and must be, the considered opinion of everyone with the future development and prosperity of South Africa at heart.

The method of roadmaking in this country is primitive in the extreme. Generally speaking, a ganger or two—with no claims to mechanical knowledge, assisted by a few natives, start the work on some vague general principle. Progress is extremely slow, and results as a rule, in a very short space of time, are decidedly unsatisfactory. While the work, for the more prosperous municipalities, may be done on more scientific lines and under better and skilled supervision, even in such cases our best roads compare very unfavorably with the modern mechanically constructed highways of America and Europe.

In the past ten years vast improvements have been made in roadbuilding methods; and the construction of straight, graded, and permanent highways, laid down in a minimum of time with modern machinery, is practical politics. We need a system of well-planned roads that are able to withstand our violent storms and floods: roads that admit of transport traveling at a good rate of speed and that are otherwise suitable for the mechanical transport which has to a very great extent superseded the old horse vehicle and ox wagon.

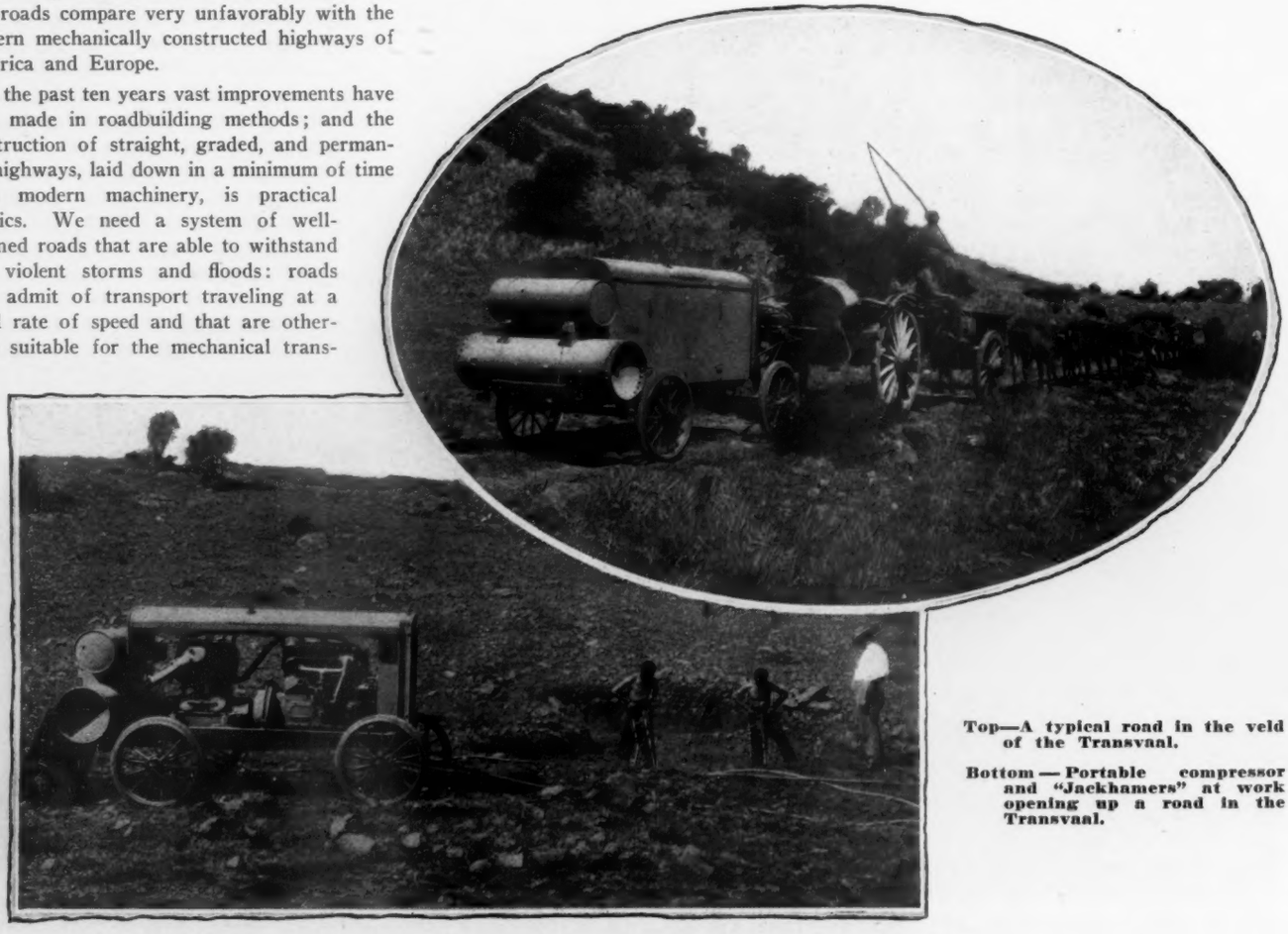
In all great engineering projects of today, compressed air plays an important part, and this applies to all classes of road construction and maintenance. Compressed air, because of the development of convenience and efficient portable compressors, has been made available for many operations formerly performed entirely by hand labor. The saving resulting from the use of air tools operated by such means is remarkable indeed—great economies being effected in labor, time, and expense.

Portable air-compressor outfits to cope with this class of work are in use the world over. Not only do they save the cost of setting up, tearing down, and moving a nonportable unit, but they do away with lengthy pipe lines, boiler plants, and other impedimenta. A portable rig is in every way to be preferred to a stationary outfit.

A modern portable air-compressor outfit is a complete, self-contained plant. Nothing is lacking—it is ready to go to work as soon as the fuel, water, and oil are supplied. A very rigid cast-steel frame is used. On this are mounted the vertical compressor with regulator, the engine, the air receiver, the closed-circuit cooling-water system for both the compressor and the engine, the radiator, fan, pump, and fuel tank.

These outfits are made in six different sizes to suit the work in hand; and, from practical experience, it has been found that an outfit operating two paving breakers will do the work of a gang of 30 native laborers. Portable compressors are mounted in a variety of styles, the smaller sizes being suitable for mounting on motor trucks that insure very rapid transport from place to place.

"Jackhamers," the small hand-hammer drills that have done so much to reduce rock-drilling costs, are especially adapted to excavating rock and to breaking up boulders, which are obstructions met with in roadmaking. They speed up the work and bring down the cost. These drills are made in all suitable sizes, and will therefore handle any class of work encountered—such as heavy excavating, bench work, or tunneling, and are equally suitable for narrow trench work.



Top—A typical road in the veld of the Transvaal.

Bottom — Portable compressor and "Jackhamers" at work opening up a road in the Transvaal.

Portable compressors and paving breakers are proving very helpful in building roads in the country and in repairing highways in the populous centers of South Africa.

Another important pneumatic tool for roadwork is the pneumatic clay digger designed primarily for work in stiff clay, hard sand, and gravel. The following comparative data strikingly shows the difference between hand picking and pneumatic picking:

Hand Picking	*Rate of Excavating*
Six men with hand picks working 8 hours per day	30 cu. yds. per day
Average rate per man..	5 " " " "
Pneumatic Picking	
Six men with clay diggers working 8 hours per day	66 " " " "
Average rate per man.	11 " " " "
Increase in working rate per man with pneumatic clay diggers...	6 " " " "

Pneumatic tools of all descriptions are indispensable for much of the incidental work, such as bridge work and construction work, sometimes involved in roadbuilding. The time and money saved by using riveters, chipping hammers, metal drills, grinders, etc., more than justify the outlay entailed.

One of the foremost firms in the development of modern roadmaking plants is the Ingersoll-Rand Company, who have supplied pioneer outfits to the principal cities of the world. Their experience and great resources enable them to place on the market plants particularly suitable for South African conditions.

Reprinted by courtesy of the South African Engineer.

TESTING HYDRAULIC BRAKES FOR OIL TIGHTNESS

TO insure the fluid tightness of the 4-wheel hydraulic brakes with which their cars are equipped, the Paige-Detroit Motor Car Company thoroughly tests these safety appliances under pressure. First, the oil lines are thoroughly cleaned with air at high pressure so that no foreign matter is left in the tubing before assembling in the finished frame.

For the purpose of the test, short lengths of rubber tubing are attached to the bleeder valves of the brake actuating cylinders. The system is then linked with a test pump at the point where the reserve supply of liquid is carried in the completed car; is filled with liquid by the aid of the pump; and the air and the liquid in the system are "bled" through the bleeder valves and the rubber tubing into small pails until only pure liquid containing no air bubbles can be drawn. After that the bleeder valves are closed and the pressure is raised to 300 pounds per square inch. Under such pressure the tiniest pinhole will spurt a jet of liquid many feet and the smallest leak will make its presence known on the pressure gage. When the hydraulic brakes have thus been proved tight, the test pump is disconnected and the braking system is left filled with the fluid.

Testing the hydraulic braking system of a new motor car.

We are advised by the *Foreign Railway News* that a removable roof for freight cars has been patented by a Swedish inventor. The roof is divided into two equal parts that move sidewise so as to open the car from end to end. The bearings of the roof are mounted on the end walls of the car. A number of these new cars are now being tested by the Swedish State Railways for hauling charcoal. The principal advantage claimed for the removable roof is that it permits loading and unloading by means of cranes instead of by hand.

The simple equipment that makes it possible for a naked diver to descend to depths ordinarily requiring a far more cumbersome outfit.

LIGHT-WEIGHT APPARATUS FOR DEEP DIVING

AN unusual type of diving apparatus has been devised by a Frenchman that is said to enable a man to descend to depths in which regulation diving dress is usually required. In this apparatus, the air—furnished by a pump on the surface—is stored in a pocket attached to a belt strapped around the diver's waist. In this pocket the air is stored at a pressure equal to that of the surrounding water—the pressure of the water, of course, varying with increasing depth.

After the apparatus is adjusted to the body, the diver draws a deep breath and empties the pocket of its contained air—the air passing through pipes and a valve before entering the lungs by way of a rubber mouthpiece. The vitiated exhaled air, together with any excess air from the pumps, escapes through an expiration valve. The rubber mouthpiece is placed inside the mouth between the lips and the teeth; and an India rubber mask, designed for the protection of the eyes, can be adjusted if desired. Divers, it is claimed, have been known to change these diving masks successfully underwater.

A submarine worker so equipped may dive head first into the water, being guided in his descent by a weighted signal cord. Or he may allow the cord to slip between his legs, sliding down on it in an upright position much as he would on a pole. To come to the surface, the diver allows the cord to slip between his legs, thereby regulating the speed of his ascent. It is claimed that a naked diver with this apparatus can reach the same depths to which a man in an ordinary diving dress can descend; and, besides, he retains all the freedom of the swimmer. If the pump should stop delivering air he can easily remove the apparatus and return to the surface.

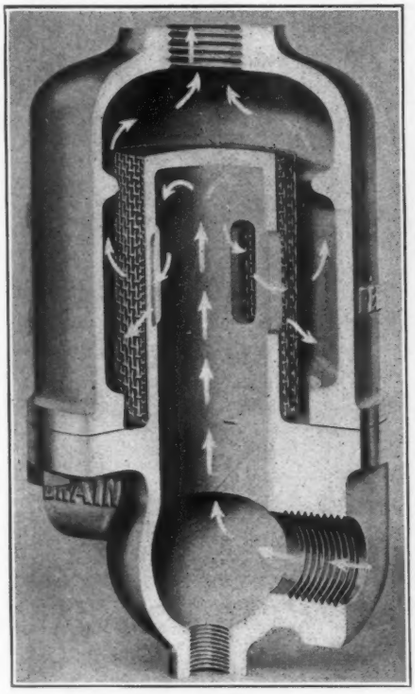
Hawaii's three leading agricultural export crops—sugar, pineapple, and coffee—are estimated to have reached a value of $100,000,000 in 1926. Sugar is the principal product, accounting for $66,000,000.

Great economies were effected last year by the common carries of the United States through a reduction in the consumption of coal brought about primarily by a better supervision of the fuel used and by the employment of improved types of locomotives. According to the *Railway Age*, the coal bill for the operation of both freight and passenger trains was about $75,000,000 lower in 1926 than it would have been had the efficiency of the fuel burned been no higher than it was in 1920. As a result of this increase in efficiency, about 29,000,000 tons of coal were saved in 1926.

NEW SEPARATOR FREES AIR OF OIL AND MOISTURE

WATER in compressed air gives rise to numerous troublesome difficulties that are apt to prove costly. Accumulations in pipes cause rust and subsequent fouling. Water hammer may develop and induce loosened joints and air leaks. Water will exclude the lubricant from valves, pistons, and other moving parts of air-driven tools and appliances, thereby adding to the friction and causing rapid wear. Rapid wear means inefficient operation and early repairs and replacements. Take air brushes or air sprays, for example. To produce a perfect finish, they are dependent upon compressed air that is free from moisture.

Air and water in compressed air can be removed in different ways; but the two principal means employed are water-cooled aftercoolers and mechanical separators. The aftercooler is usually placed in the discharge line leading from the compressor and is more frequently used in connection with the larger installations. There are, however, comparatively small sizes available. Mechanical separators, of which there are several makes, can be located at desirable points throughout the system. A new separator of this kind has recently appeared in the field—namely, the Gast compressed-air separator which is shown in the accompanying illustration.



Sectional drawing of the Gast separator illustrating the course followed by the air in passing through this cleansing apparatus.

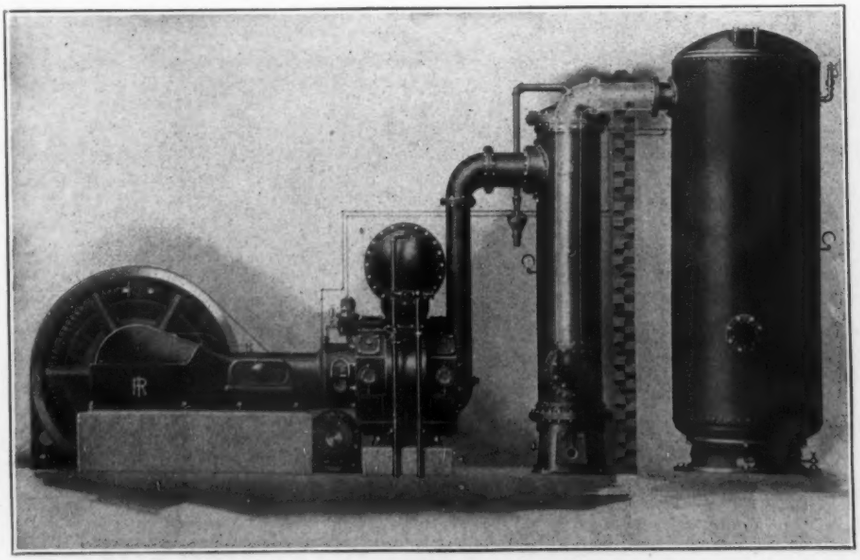
Compressed air, carrying oil and moisture, enters the separator through the horizontal inlet, as indicated by the arrows. From the top of the inner chamber the air is deflected downward through many thicknesses of coarse brass screening and outward by way of the slotted openings. The screens impede the flow of air, forcing it to follow a zig-zag course to reach the outer chamber. It is claimed that these sudden changes in direction throughout so short a distance of travel cause the moisture and oil to be deposited on the strands of screen and to fall into a dead air space at the bottom of the outer chamber. Before leaving the outer chamber the air must pass around a projection cast in the upper part. This is designed to prevent any capillary action and to keep the air in the upper chamber free from moisture.

The water and oil collected at the bottom of the outer chamber are drained through a drop pipe with a shut-off valve. Automatic drainage may be provided by connection with a self-discharging trap. At the bottom of the separator is a low-point drain in the form of a smaller opening. This can be fitted with a short drop pipe and air cock. Separators of this make are supplied in sizes to fit either a ¾-inch or a 1-inch line. Individual separators are recommended for each air line.

COLD NEEDED IN REFINING COD-LIVER OIL

REFRIGERATION is a step in the production of high-grade cod-liver oils in Newfoundland, according to a bulletin of the British Imperial Institute. After washing the livers in clean, fresh water, they are placed in pans and treated with open steam for 30 minutes. When the resulting liquor has settled for 5 minutes, the oil is decanted and strained through flannel, calico, or moleskin into a cooling tank where it remains until the following day. It is next strained through cheesecloth into casks. This first fraction obtained from the livers is the only portion of the oil used for medicinal purposes, and is further refined before use.

This refining is effected by chilling the oil to facilitate the removal of the separated stearin—an ammonia plant serving to keep the temperature of the mass at 18°F. After being kept in the tin vessels and at that temperature for three days, the oil is decanted and allowed to drain from calico bags. As a final operation, it is strained through muslin and transferred to tin-lined barrels. As far back as 1888, Newfoundland manufacturers resorted to chilling to enable them to get rid of the stearin. Five years later, the direct-steam process was introduced; but, even so, the finest grade of cod-liver oil is still obtained by the aid of refrigeration in the final stage of the refining operations.



General arrangement of a compressor installation showing the manner in which a vertical aftercooler is interposed between the compressor and the receiver. The discharge from the compressor is delivered to the upper part of the aftercooler, and the compressed air leaves the lower part of the aftercooler and goes thence to the top of the receiver. In extremely cold climates, the receiver would be placed inside the building.

HIGH TEMPERATURES YIELD SUPERIOR COKE

EXTREMELY high temperatures are best suited to the making of coke, according to F. F. Marquard, superintendent of the Clairton plant of the Carnegie Steel Company. A statement to this effect was made by Mr. Marquard in a paper read by him at the coal conference held not long ago in Pittsburgh, Pa., and is the outcome of protracted work in cokemaking with varying oven temperatures.

The entire group of 1,500 ovens at Clairton—the largest coke plant in the world—was operated for considerable periods at temperatures ranging from 1,600 to 2,100°F. in 50° stages. Twenty-four blast furnaces are regularly supplied with coke from this plant, and the behavior of these furnaces in the manufacture of pig iron was observed with the cokes made at these different temperatures.

It was concluded that superior furnace performance was obtained with coke produced at the higher temperatures—the superior performance involving both greater iron output and greater fuel efficiency. It was while using coke made at 2,100° F. that one of the blast furnaces made a world record in producing on an average 823 long tons of pig over a period of thirty 24-hour days. This big output was secured through the use of only 1,825 pounds of coke per ton of pig iron.

Air-driven "Jackhamers" used effectively in hastening the razing of a reinforced-concrete wall in Buffalo.

CONCRETE WALLS QUICKLY DEMOLISHED

MOST construction jobs in any city or in any industrial community of importance call first for the removal or demolition of standing structures for the purpose of clearing the way for new work. The task is often a hard one for the wrecker because the structure to be disposed of was reared with the idea of permanence and its razing is, therefore, somewhat difficult to accomplish. Hand methods are inadequate and costly in dealing with jobs of this character, and the contractor or wrecker—call him what you will—has generally found it to his advantage to use mechanical aids in clearing the way for the new structure.

A good example of this method of procedure is the demolition of a reinforced-concrete wall which was recently effected by the Gleasner Compressed Air Supply Equipment Company of Buffalo. The length of the wall in question was 163 feet; it was 11 feet high; and was 15 inches thick at the top and 24 inches thick at the bottom. The air-driven tools used to do the work were two "Jackhamers," one of the BAR and one of the BCR types. The method employed was to drill 1½-inch holes, spaced 2 feet apart, in the top of the wall to a depth of about 4 feet; next a row of horizontal holes was drilled in the wall about 4 feet above the base; and, finally, another row of holes was drilled in the base—the latter holes being pitched and drilled to a depth of approximately 2 feet. Blasting was done with half sticks of 1¼-inch 60 per cent. dynamite. All this work was done on a much-traveled street; and the whole task was completed by three men in 55 hours. Air for the "Jackhamers" was furnished by an 8x8-inch Type Fourteen portable.

Until within recent years little synthetic ammonia was manufactured in Japan. At present there are two large plants, producing approximately 400,000 pounds per year. These are being enlarged, and a future annual capacity of 1,000,000 pounds is expected. This increased output will probably enable Japan shortly to fill all her requirements from domestic sources. Anhydrous ammonia is used for refrigeration and in the manufacture of ice. The demand for ice is growing steadily in Japan—an indication of the country's continued prosperity.

NEW CELLULAR CONCRETE

CONCRETES with specific gravities ranging as low as 1 to .1 have been developed in the laboratories of the Polytechnic Academy at Copenhagen, Denmark, by E. C. Bayer. A cellular structure is obtained by producing an aerated mass by the addition to the cement and sand of a foaming admixture of soap and albumen, only about 1 part to 2,000 parts concrete being used. The foam is prepared in a separate mixer, the required agitation being done by compressed air.

It is claimed that this type of cellular concrete meets the demands for a light, durable building material, which is capable of being cut and planed; and it has also been proved to be an effective insulator. Such a concrete having a specific gravity of unity has a compressive strength of 1,000 pounds per square inch. For concretes of lower gravities the strength is found to diminish rapidly with decreasing density. Concrete of this variety will float in water and, unlike brick, will not become waterlogged.

Because of its insulating properties, it is suitable for lining either hot or cold spaces. It is also claimed to be highly resistant to sudden temperature changes—blocks of it having been heated and immersed in water without injurious effects. Ordinary concrete blocks were badly damaged when subjected to a similar treatment.

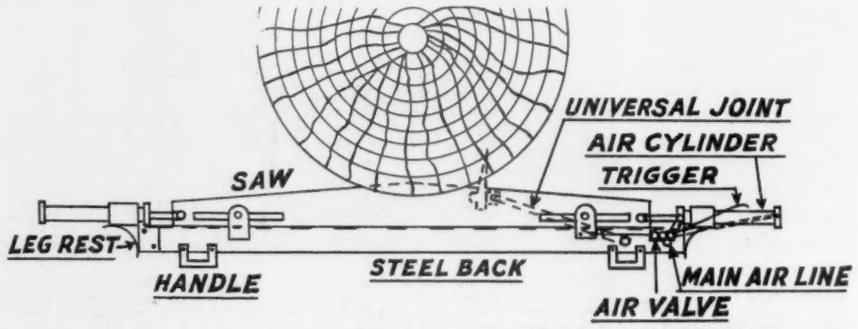
AIR-DRIVEN FALLING SAW

A TIMBER-falling saw powered by compressed air has been patented by two British Columbia lumbermen—James Day, of Powell River, and Robert C. Samson, of Vancouver. As the machine weighs but 75 pounds and operates at a speed of 200 strokes to the minute, it combines ready portability with high efficiency.

At one end of the saw is a double-acting cylinder. The air-control valve is operated from a slot in the saw which opens and closes at each stroke. The lumberman stands at this end, where a trigger spring is provided for opening or closing the air-supply main. A cylinder at the other end, containing air at atmospheric pressure, acts as a cushion for the stroke. The cylinders and saw are attached to a steel back which gives added strength to the frame. This back is so made and fitted that it can pass through the cut made by the saw.

Before a tree is to be felled, a spike is driven into it below the cutting plane. To it is attached a universal joint connected by a rod to another joint on the underside of the frame beside the lumberman. This joint takes up the natural thrust of the saw, yet enables the operator to swing around the tree in cutting.

In discussing the timber-falling saw, Mr. Samson said: "The machine will operate at a great distance from the compressor, which can be located at any convenient point, and rubber hose led into the timber. When we begin to manufacture the saw for the market, both the saw blade and the steel back will be narrower than they are at present to enable the operator to follow the saw with wedges in the usual manner. The cylinder will also be larger in bore, giving at least twice the power, so that there will be no question as to the saw maintaining an effective speed."



Courtesy, The Timberman.

Sketch of the Day-Samson falling saw.

Enlargement of Hoosac Tunnel Completed

This Work Emphasizes the Great Progress Made in Pneumatic Equipment Since That Famous Tunnel Was Built

By J. E. HARDING

EARLY last year, as a part of its campaign of track and line betterment, the Boston & Maine Railroad decided upon extensive improvements of the famous Hoosac Tunnel on its "Line of the Minute-Man" from Boston to Troy. The work, as laid out, embraced the lowering of the grade of both traffic lines at the west portal about 18 inches to ease the grade to that approach. This necessitated excavating the ballast and the subgrade to a depth of 33 inches, as well as the removal along the sides and the spring line of the arch of the tunnel of all rock inside a predetermined cross section to increase the clearance so as to accommodate the largest rolling stock of the railroads of the country.

In the prosecution of this work, compressed air played as important a *rôle* as it did in 1866 when Charles Burleigh designed and placed in service in that tunnel the drill that still bears his name—the first pneumatic rock drill used in mining work in America. Furthermore, the air for those drills was supplied by compressors especially designed for the purpose.

As compared with the present types of rock drills and compressors, those early models were cumbersome and heavy. The Burleigh drill weighed 540 pounds; struck 200 to 250 blows per minute; and operated on air at 65 pounds pressure—drilling a 1¾-inch-diameter hole 5 feet deep. Twelve drills were used at each working face, and these were mounted on carriages—each carriage carrying six machines. Even to this day, drill carriages are employed in some places and under certain conditions. The compressors that furnished the air back in 1866 had pistons, 13½ inches in diameter, with a 20-inch stroke; and each unit embodied 16 of these so-called air pumps. One compressor plant and four 20-H.P. hydraulic turbines were located at each end of the tunnel; and there was also a steam-driven compressor plant on top of the mountain at the collar of the intermediate shaft which was sunk 1,040 feet to the line of the tunnel.

Blasting was done with nitroglycerine manufactured on the job by G. M. Mowbray, a famous chemist of those days. It is stated that the blasting with nitroglycerine cost ten times as much as it would have cost had black powder been used. But as no ventilating air was provided other than the compressed air exhausted from the drills, black powder could not be employed because the smoke after blasting would have been unbearable in the confined space. During the twenty years in which the tunnel was being driven—at a time long before the introduction of the slogan "Safety First," 136 men were killed in one way or another.

Work on the driving of the long bore was started in 1854, and was carried on by hand until 1866. The technical journals of that day, such as the *Engineering News* and the *Scientific American*, published lengthy and interesting articles on what was then considered a wonderful undertaking in the engineering world. From what the *Scientific American* had to say, it

At the time this picture was taken the work of lowering the left-hand track was in progress—all traffic being taken care of on the track to the right. Note the three portable compressors that furnished the necessary air to drive the "Jackhamers" used to remove the rock in lowering the roadbed and in enlarging the tunnel arch. In the center of the group is the Track Supervisor, W. L. Shanks, under whose supervision the work was done. At his left is Gerald A. Haskins of the engineering force of the Boston & Maine Railroad.

seems that between the years 1854 and 1866 funds for the work were available only when a liberal Massachusetts legislature could be induced to appropriate the necessary money—operations coming to a halt when a recalcitrant legislature tightened the purse strings. Evidently, politics as well as compressed air played an important part in the prosecution of the project.

Finally, in 1866, a contract was let to Francis & William Shanley, contractors of experience; and from then on the work progressed steadily until it was finished in 1874. In many places the walls were lined with an 8-course brick reinforcement. According to some people, the tunnel was opened to traffic in 1874, while others claim that it was not actually used until 1876. This detail is at present unimportant; but it should be of interest to know that the tunnel cost $1,900,000 per mile.

In the prosecution of the present work, DCR-23 "Jackhamers," weighing 58 pounds, were capable of drilling the mica schist at the bottom of the tunnel at a rate faster than 1 foot per minute; and compressed air to actuate both the "Jackhamers" and a clamshell excavator, handling the spoils in the tunnel, was furnished by a battery of Ingersoll-Rand portable, tie-tamper compressors. It is, indeed, a far cry from the equipment used to build the Hoosac Tunnel to that which is now generally employed on kindred work. But it is an outstanding fact that improvements in design and materials, increased operating speed and reduced weight, are as much in evidence in modern rock-drilling equipment as in most all other mechanical tools and machinery in use today.

The Hoosac Tunnel is 25,000 feet in length, and is traversed by a double-track standard-gage railroad—a trolley supplying the power needed to operate the heavy electric engines that haul the trains back and forth through the tunnel. The central shaft, originally sunk so that the work of tunneling could be advanced simultaneously from several headings, now serves for ventilation.

Numerous difficulties were overcome by the Boston & Maine maintenance, engineering, and operating forces in carrying out the work of enlarging the tunnel. In the first place, as traffic had to be maintained at all times, it was decided to lower one track and to run all trains, whether going or coming, over the other track.

The disposal of the spoils presented the greatest problem. The excavated material could not be loaded in cars and thus carried away on account of interfering with the dense traffic on the main line. This difficulty was overcome by an ingenious use of a cable conveyor. As shown in the accompanying illustration, one end of this cable conveyor was supported by a heavy stayed mast, set up on a hill beyond the distant tunnel portal, while the other end was anchored down on the side of a hill near the portal seen in the foreground. The muck in the tunnel was loaded into trays on trucks, and transported to the farthermost portal where the trays were lifted to the standing cable by a steam hoist, conveyed, and dumped on the waste pile visible in the middle distance.

Owing to the manner in which the work was handled, no serious delays in traffic were experienced; and much credit is due the engineers of the Boston & Maine Railroad that were in charge of operations not only for the way in which the work was done but also for the speed with which that section of the line was restored to regular traffic.

TRANSPARENT SHEET STEEL

SHEET steel, as transparent as the clearest glass, is the invention of Dr. Karl Mueller connected with the Physical Technical Institute of Berlin. According to *Die Post,* sheet steel of this description and of unprecedented thinness is likely to prove of far-reaching industrial as well as scientific importance. It may be used as a membrane for the separation of gases, or lend itself admirably to the promotion of television and telephotography.

Test plates used to determine the transparency of optical glass, and which were ruled with cross lines 2,500 to the square inch, were photographed through such a metal sheet. When enlarged to 400 diameters, the scale lines showed distinctly, with no trace of distortion. This absence of aberration conclusively proved that the structure of the film was perfectly even and equal in all directions. Even though the metal sheets are so thin that atoms will penetrate them without impediment, yet, when fastened in a frame, they are strong enough to be bent by blowing to the extent of one-sixteenth inch without rupture. The delicate sheets are made by depositing an extremely fine film of the metal on a smooth surface by means of electric current, and then separating the film from the foundation on which it is fixed.

MAXIMUM CARRYING CAPACITY OF HIGHWAYS

"THE maximum carrying capacity of the average road under average conditions is reached at an approximate speed of 22 miles per hour." This is the conclusion reached after a protracted study of the subject, and was brought out at the National Conference on Street and Highway Safety held not long ago in Washington, D. C.

In speaking upon the relation between the speed of vehicles and the capacity of highways, Col. N. W. MacChesney, of Chicago, made it plain that there is a rather critical vehicle speed above or below which capacity decreases. This critical speed will vary somewhat under varying conditions of road and traffic, such for instance, as the number of traffic lines, the character of the traffic, the nature of traffic supervision and direction, and the frequency and duration of traffic interruptions from cross traffic.

The popular impression is that the higher the speed the greater the capacity of a road or street for carrying traffic. Long study of traffic control in Chicago has shown that this is not true in actual practice. Both above and below the average speed of 22 miles per hour, factors arise which reduce the number of cars which a road can safely and conveniently handle under average traffic.

INDUSTRIAL VALUE OF THE MENHADEN

A VAST natural resource of value is found in the menhaden fish—a bony, oily, surface-swimming member of the herring family whose number in the various seas of the earth has been estimated as high as four thousand billions.

Though often mistakenly considered nonedible because of its bony structure, the menhaden finds wide use as a fertilizer—having first been used for that purpose by the Indians. In the United States, the industry now comprises 25 rendering plants along the Atlantic coast.

The fish are caught in nets—airplanes sometimes being used to advantage in locating the schools—and are then transported to the reducing plants in steam vessels. There they are cooked by steam, and the oil is extracted by pressing. The scrap is dried and ground, the finished product containing about 10 per cent. nitrogen and approximately 15 per cent. bone phosphate of lime.

The oil is finding increasing application—being employed in steel mills for tempering, as a substitute for linseed oil in paints, in the linoleum industry and, after hydrogenation, as a soap fat. Research has progressed to the point which would seem to indicate that the oil will soon be converted into an edible fat on a commercial basis.

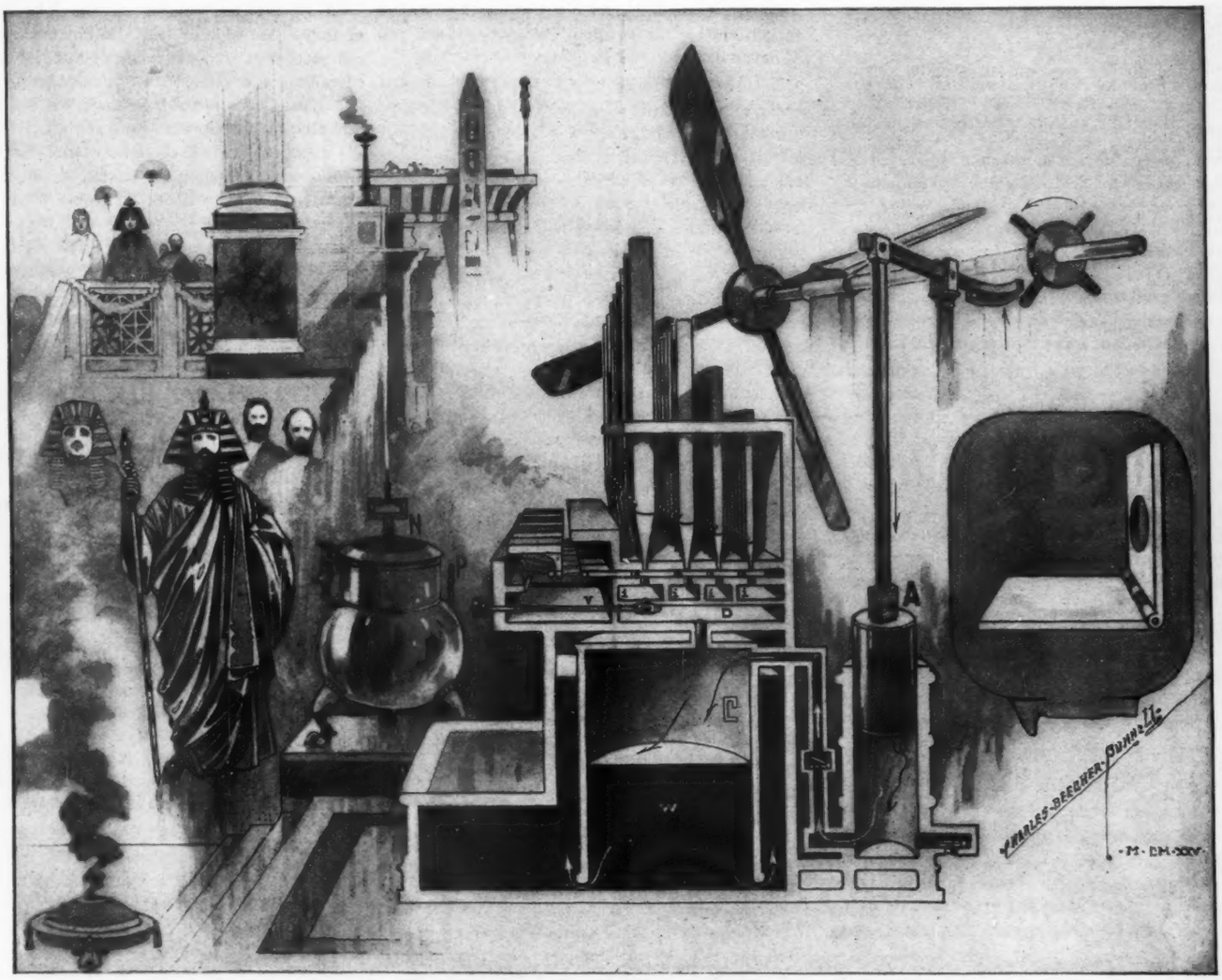
The potentialities of the menhaden industry can be best illustrated in figures. If 1 per cent. of the estimated total of these fish was to be taken and converted to man's use each year it would yield 400,000,000 gallons of crude oil and 3,700,000 tons of fertilizer.

BIG ADVANCE IN PRODUCING OIL FROM COAL

THE Coal Research Institute, at Muehlheim, Germany, according to *Commerce Reports,* has announced recently that it has solved the problem of producing oil from coal without pressure and at the comparatively low temperature of 518°F. A cobalt and chromium oxide catalyst is used, which, if especially activated, produces gaseous, liquid, or solid petroleum hydrocarbons. If a strong base activator is applied, such as caustic soda or potassium carbonate, the yield is more of high-boiling and solid petroleum hydrocarbons. Weaker bases, such as soda ash, yield a product more or less similar to crude oil; and barium hydroxide gives an intermediate between these.

The several gases containing carbon monoxide and hydrogen, such as generator and blast-furnace gas, or even illuminating gas to which hydrogen has been added, may be substituted for water gas, in synthesis, according to reports. The gases, however, must be free from sulphur compounds, which poison the catalyst and destroy its effectiveness.

The theory is that the carbon from carbon monoxide combines with the catalyst to form a carbide, stable at low temperature. The hydrogen decomposes the carbide, regenerates the catalyst, and combines to a hydrocarbon of the methane series.



CTESIBIUS PLANNED AN ORGAN TO BE BLOWN WITH COMPRESSED AIR

FERTILE-minded Ctesibius, of ancient Alexandria, furnished material for much of Hero's subsequent writings; and the following will illustrate the inventiveness of that physicist, who lived about 250 years B. C.

Hero, in his 77th Proposition, thus describes the Ctesibius Hydraulica—an altar organ blown by the agency of a windmill that actuated an air compressor, "A." The air compressor consisted of a "turned metallic piston" and a "bored bronze cylinder"—the heavy piston dropping by its own weight as the tappet wheel on the windmill shaft released the lever and connecting rod.

The compressed air was delivered to a storage chamber, "C," that connected with a distributing chamber, "D." The storage chamber was formed by inverting a cylinder in a water tank. As air was pumped into the chamber "C" the water, "W," was displaced and forced down and out into the main tank, as indicated by the white arrows. This displaced water, continually trying to resume its normal level, served to maintain the air compression at a nearly constant point. Fig. "V" is one of the four air valves in the distributing chamber "D," placed beneath each of the octave supply chambers, "1," "1," "1," "1"—so that four, three, two, or one octave might be played by the organist at will. Nero, the Roman tyrant, was so pleased with the organ that he had a coin struck in its honor.

Hero's 9th Proposition deals with Ctesibius' compressed-air fountain—used at banquets to spray perfumed water. The necessary compression was supplied by a small hand pump, "P." By depressing the nozzle, "N," 90 degrees, the fountain stopped, but the air chamber retained its pressure.

Hero's 10th Proposition describes the "hinge valve," the valve most used by ancient mechanics. It was first carefully fitted and then polished.

It is said that Ctesibius was able to pump water to the unusual height of from 70 to 90 feet because he employed a cushion of compressed air on the underside of his pump pistons.

A PROCESS for protecting aluminum from oxidation and corrosion with metallic finishes of various colors has been developed in Germany. It consists of dipping or boiling the article to be finished in baths containing solutions of copper, zinc, tin, or other metals and their alloys. The effect so obtained can be further varied by polishing the aluminum before and after treatment, by applying a thin coating of wax to the finished surface, etc. As no electric current is used in the bath, metal plating does not take place. Instead, it is claimed that an actual "amalgamation" is effected with the surface of the aluminum.

In the course of a lecture to the Heriot-Watt College, Emeritus Professor Henry Louis said that the only appliance which has been used at all extensively in practice for dry-cleaning coal is the Sutton-Steele table, which is, in fact, a Wilfley table. The surface of this table consists of a permeable material, while the table forms a shallow box into which air is blown. The streams of air passing through the surface of the table lift and stratify the coal, so that the clean coal passes straight down the table, while the refuse travels along the riffles and is discharged at the end—middlings being carried off at an intermediate position.

Until about 1906, the oil industry existed mainly to supply kerosene. At that time, gasoline was virtually a waste product: now it is the principal constituent obtained from the crude oil.

Compressed Air Magazine

—*Founded* 1896—

Devoted to the mechanical arts in general, especially to all useful applications of compressed air and to everything pneumatic.

Business and Editorial Offices:

Bowling Green Building, No. 11, Broadway, New York City. Tel. Bowling Green, 8430

Publication Office: Somerville, New Jersey

TERMS OF SUBSCRIPTION

$3 a year, U. S. A., American possessions and Mexico; all other countries $3.50 a year, postage prepaid. Single copies, 35 cents. Back issues more than six months old, 75 cents each.

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EDITORIALS

PATIENT RESEARCH EVOLVES SUPER-OYSTER

FOR a long while the oyster has been cited as a superlative example of the uncommunicative. Similarly, the oyster has persisted in his own ways and has generally refused to change for the better in any given environment. Therefore, we have had oysters of various sorts and of different sizes agreeably to the particular habitat in which each of the kind flourished. That is to say, we have had oysters that ranged in size all the way from the costly and rather miniature Olympia bivalves of the Pacific coast to the big and reasonably low-priced Lynnhaven Bays of the Atlantic seaboard; and in flavor the oysters have differed widely.

As might be expected, the patient man of science, realizing what has been achieved through cross and interbreeding in bettering other forms of animal life, would not believe that the oyster could not be likewise improved by kindred treatment. Therefore, he set himself the task of wringing from the oyster some of its biological secrets; and, undismayed by numerous setbacks and difficulties, he has at last succeeded in growing oysters from carefully nurtured eggs that are, indeed, superior in size, flavor, and rapidity of growth. This climax is the outcome of investigations started in laboratories something like half a century back—the aim then being to grow oysters from eggs for the purpose of ultimately obtaining types that would be bigger and better and more profitable for the oysterman to handle. For nearly five decades the oyster hid the secret of possible betterment from the inquisitive man of science. But finally, one WILLIAM F. WELLS, a biologist of the New York State Conservation Commission, devised means by which certain elusive things about the oyster could be discovered.

Before Mr. WELLS tackled the problem, efforts to isolate the eggs of the oyster failed because any filter paper fine enough to arrest impurities in the water was, nevertheless, porous enough to permit the extremely minute eggs to pass through and to escape. The problem was in the end solved by utilizing an apparatus modeled in principle upon the lines of a rotary cream separator—the sought-for eggs being left clinging to the surface of the separator while the undesirable impurities were carried off. The eggs so saved were from day to day stimulated with fresh water and brought step by step to maturity. In this manner, oysters with a pedigree were produced; and these were interbred until the outcome was a type that might fittingly be designated a super-oyster. This patient work bids fair to be of great value to the oyster-growing industry and of immeasurable delight to one and all of the oyster-consuming public.

ST. LAWRENCE SHIPWAY AGAIN URGED

SO far as engineering reports can advance the cause of the St. Lawrence shipway project, that long-advocated scheme may now be considered one step nearer solution and undertaking because of the report that has recently been submitted to the two governments immediately concerned.

It will be recalled that a report was made in 1921 by engineers representing the two governments—the report being made at the time to the existing International Joint Commission. It will also be recalled that the experts advocated the shipway project and the erection of certain dams that would serve not only to control the waters of that great stream for purposes of navigation but would utilize those waters for the generation of very large blocks of electrical energy. Certain essential economic and engineering aspects of the subject were not entered into in the 1921 report, and it was deemed advisable to cover those points by a further examination of the subject before either government arrived at a decision in this momentous matter.

Accordingly, a joint board of engineers, called into being by the two governments in 1924, has had the subject under consideration in the meanwhile, and its recommendations—submitted recently—indorse in a general way the recommendations made by the engineers in 1921. The thing that stands out is that while the Canadian and the United States engineering representatives are broadly in accord they are not in agreement as to some of the outstanding details of the project. Furthermore, the cost figures presented in the 1921 report are considerably increased in the report that has lately been submitted. Indeed, it may be taken as axiomatic that the longer work is postponed the heavier will be the ultimate outlay—not because physical difficulties will grow but mainly because basic costs are likely to rise in the meantime.

There are two angles of the subject that must be considered apart, although they are necessarily interrelated: one is the desirability of giving the states contiguous or near to the Great Lakes a water route to the sea at the earliest practicable date; and the other is finding a market for the electricity which could be produced at the start far in excess of the demands of any available market. Whatever action may be taken by the governments of Canada and the United States upon the strength of the latest report, the public should take a lively interest in the subject, because sooner or later some definite course must be chosen.

DIPLOMACY BINDING US CLOSER TO CANADA

THE fact that Canada is now represented at Washington by a minister is evidence of the growing importance of the diplomatic relations between the United States and the Dominion. The two countries have reason to rejoice in this outgrowth of neighborly intercourse, that must inevitably lead to still closer ties between them. Each can gain much from the problems confronting the other.

In a broader sense, Canada is still youthful and in the pioneer period of development which calls especially for initiative, courage, and a willingness to push forward valiantly in the face of natural obstacles. In the United States, progress has generally reached a point that no longer calls for the pioneer spirit that once was needful to make us aware of the great resources lying within our borders. The dimming of this spirit represents a distinct loss, because in many departments of life the same urge to go ahead remains even though the physical roughness of the way may have disappeared. Therefore, we can borrow inspiration from the example that Canada is setting by her initiative in many parts of her vast domain.

But aside from this aspect of the subject, there are the best of material reasons for fostering fuller intercourse, better understanding between Canada and the United States. Canada not only has drawn generously for years upon the United States for necessary capital to develop and to promote her own industries but, in return, she buys 65 per cent. of her imports from us. This reciprocity in monetary matters is something that is of reflex benefit to all the people of each of the great nations concerned. Each, in short, is more or less dependent upon the other; and the recognition of this interdependence should lead to the most cordial and neighborly relations.

SERVICE VALUE OF STATE TRUNK HIGHWAYS

MOST of us are unaware of the service value of the nation's highways. The United States Bureau of Public Roads dealt with this subject not long ago and took for example the figures available in connection with the highway system of the State of Connecticut. In the course of a year, the 1,114 miles of that state trunk-highway system had a traffic record

of 414,000,000 vehicle-miles, which represented 58,000,000 net ton-miles of commodities and 974,000,000 passenger-miles.

Recognizing the many factors of a more or less unascertainable nature that enter into the complete valuation of a highway system and its reflex benefits, the Federal authorities have, at least, arrived at a definite service figure based upon the salvage value of the improved highways in Connecticut, which was put at approximately $23,000,000 in 1923. Using that estimate as a basis for calculating the service value of the system to highway users, it was ascertained that the system earns an annual return of about 23 per cent. on the investment.

Manifestly, the earning capacity of any highway system will depend in a large measure upon the engineering skill displayed in building the roads in the first place and the care taken afterwards to maintain the roads so that they will make rapid and continuous traffic possible the year round. In the building and the upkeep of trunk highways of this sort the use of modern and efficient equipment is indispensable. We need not emphasize here how big a part compressed air plays in this work.

It is interesting to point to the fact that the progress made in the art of roadbuilding in the United States has not gone unnoticed abroad. Recently, the Cuban government entered into an agreement with certain American financiers for the purpose of obtaining an ultimate credit of $70,000,000 to defray the cost of constructing a central highway that is to run from end to end of the island, and to have a total length of 700 miles. An American firm has been awarded the initial contract, and a credit of $10,000,000 is now available to start operations.

VOCAL COMMUNICATION DE LUXE

TRANSATLANTIC telephoning by radio is an accomplished fact. This achievement is the climax of the cumulative efforts of many men over a period of something like a quarter of a century—evolving from the pioneer work of MARCONI who blazed the way with wireless telegraphy.

Recalling all the difficulties that beset MORSE and FIELD in the first years of cable communication beneath the ocean; and bearing in mind how gradual and how costly has been the evolution and the expansion of subaqueous telegraph systems—upon which we have so long depended as a means of rapid and far-reaching intercontinental communication, the coming of cross-ocean speech by radio seems all the more amazing. And yet, notwithstanding the really startling nature of this scientific achievement, still the public at large is relatively but little stirred—excepting, of course, those few persons that are willing to pay the price to win for themselves the distinction of being among the first to use this newly instituted commercial system of vocal intercourse. This comparative indifference is due to the fact that radio, as it is popularly understood, has become a commonplace to millions of us. Furthermore, the owner of every radio set knows much about the limitations of his apparatus and is well aware of how atmospheric conditions may render his equipment all but useless.

Significant and suggestive as the achievement is that has made the transatlantic radio telephone practicable and practical in a large degree, still the system is of necessity far from a perfect one, and it may be many a day before it will prove a formidable competitor of the submarine cable. This is not said for the purpose of disparagement, but merely to make it plain that many technical obstacles have been surmounted and many others will have to be disposed of before the radio telephone will be on a par with the telephone with which we are all familiar.

The transatlantic radio telephone must contend with static, and distance will probably intensify the disturbing effects of this electrical condition of the atmosphere. Furthermore, even when the air is in a favorable condition for the transmission of the speech waves, still the radio engineer has not yet devised ways by which privacy of communication can be assured. Time and much experimenting will probably solve some of these puzzling problems; and, in the meanwhile, most of us will have to look upon this new application of the radio telephone as something in the nature of a luxury—much as we may marvel and laud the enterprise of the people that have made it possible.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION for 1925. An illustrated volume of 633 pages, published by the Government Printing Office, Washington, D. C.

AS usual, the General Appendix of the Report contains many scientific papers of outstanding interest that cover a topic scope that is calculated to afford absorbing information to a very wide circle of readers. It is not possible here to review the numerous papers reproduced, but a few may be mentioned to indicate the diversified character of the subjects presented. The *Potato of Romance and of Reality; Carnivorous Butterflies; Animal Life at High Altitudes;* the *Biological Action of Light; the Yeasts—a Chapter in Microscopical Science; Geology in the Service of Man; Immensities of Time and Space;* the *Relation of Geography to Timber Supply,* etc., etc.

STYLE-BOOK FOR WRITERS AND EDITORS, by C. O. Sylvester Mawson, Litt.D. A work of 213 pages published by Thomas Y. Crowell Company, New York City. Price, $1.50.

"THIS book," as the author states, "is intended both for occasional reference and for systematic study. Its object is to lay a solid foundation for the writer, the editor, and the lover of correct typography. Much of the material has stood the test of actual use in my classes and has been found of value in many proof-rooms and publishing offices." Because the written word is more important than the spoken word, it is essential that the recorded word or phrase should be correct and clearly expressive of the writer's thought or intention. Doctor Mawson's book is well put together and should prove of value to a great many people.

SALES ADMINISTRATION, by Walter S. Hayward. An illustrated volume of 498 pages. Published by Harper & Brothers, New York City. Price, $5.00.

THE book is primarily a study of the manufacturers marketing problems, and is designed to provide a manual of sales administration for sales managers and for others who require a knowledge of sales procedure and sales management.

The man at the bench commonly believes that all he has to do is to produce a well-made product to insure its purchase. As a matter of fact, skillful manufacture is only one part of the problem of marketing a commodity—much, very much, depends upon sales promotion and the men chosen for that work as units of an organization that reaches either directly or indirectly the ultimate consumer.

Mr. Hayward has dealt with his subject in a logical, a lucid, and a comprehensive manner, and we heartily commend his book to any person interested in this vital department of our industrial and business life.

EMILE BERLINER, by Frederic William Wile. An illustrated volume of 353 pages. Published by the Bobbs-Merrill Company, Indianapolis. Price, $4.00.

THE life story of Emile Berliner is the record of one more American, of foreign birth, whose inventive mind has contributed generously to the convenience and the well-being of the nation at large. Coming to a land of opportunity in his twentieth year, the new environment stimulated the creative imagination of the youth of German birth, and urged him onward even though the first few years in his adopted land gave him no chance to make anything of his inventive gift. As a matter of fact, Berliner's subsequent achievements were founded upon intensive study pursued in the face of odds in his spare hours.

In 1876, the telephone was born, and right there and then Berliner's imagination was gripped, and in his leisure moments he absorbed himself with the general problem of acoustics and the particular problem of speech transmission by wire. Curiously, his experiments led him to devise a type of microphone that proved infinitely more sensitive to vibrations than the diaphragm originally employed by Bell. To make a long story short, Berliner's microphone, as afterwards developed by him, was the agency that blazed the way for the telephone of today, with all of its amazing fields of useful service. The public at large inevitably thinks of Alexander Graham Bell when it thinks at all of the origin of the telephone; but it is only just to say that the telephone as we have it now would not be the really exquisite and effective instrument it is had not Berliner conceived his microphone. Mr. Wile has produced a readable and informative book.

STORIES IN STONE, by Willis T. Lee, U. S. Geological Survey. An illustrated book of 226 pages, published by D. Van Nostrand Company, New York City. Price, $3.00.

IN our accustomed hastening way, most of us pay little if any attention to outcropping rock formations, and because of this indifference or lack of appreciation we fail to see and to understand the stories that Time has written there. Therefore, the author has endeavored to make the whole subject of geology interesting in a popular way for the run of readers that have not the time nor the desire to delve into the technical niceties of an extremely complex and, withal, absorbing subject. He has been highly successful in his effort.

Mr. Lee rightly says: "There is romance in the rocks for him who can read their language. The fossils and the crystals, the pebbles and the sand, are the symbols in which the story of the earth is written. Some striking chapters of this great story are written in the scenic features of our own western country, in which are found most of the fine examples of natural expression here described and interpreted." With reason he believes that any thoughtful person will find abiding satisfaction in the *Stories in Stone* because they will reveal some of the wonder things concerning the earth's crust.

EXPLOITING CANADA'S PEAT DEPOSITS

ONTARIO and Quebec, that are now dependent on imported coal, may soon be able to burn fuel coming from the vast peat bogs existing in those Canadian provinces. This is the conclusion to be reached from the final report of the Peat Committee appointed jointly by the governments of the Dominion of Canada and the Province of Ontario.

Field operations, conducted by the committee 40 miles east of Ottawa, have led to the solution of various problems incident to the commercial production of peat fuel. Machines were developed for the economical extraction of the peat from the bogs. Experiments made to determine how best to treat the peat after extraction revealed that air drying is practicable, and that the essential climatic conditions prevail over a range of 100 days during the summer season.

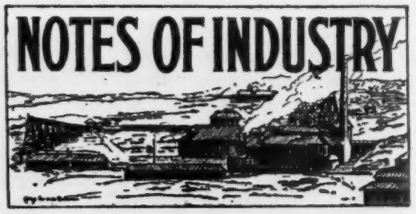
Going beyond the production aspect with its investigations, the committee made a study of the possible uses of peat coal; and of the utilization for agricultural purposes of those bogs from which the peat is not removed and also of the bogs that have been made to give up their stores of peat.

DEVELOPING DOMESTIC POTASH RESOURCES

ENCOURAGING progress is being made by United States Government exploration parties searching for domestic sources of potash. Four of the minerals existing in the famous potash deposits of France and Germany have been found in the southwestern section of the United States; and core tests will be made to determine their extent. Private capital also has started boring at several promising points.

The last Congress appropriated $100,000 for potash explorations to be carried on during the current fiscal year under the joint auspices of the departments of the Interior and of Commerce. The Geological Survey is to select the sites, make the analyses and tests, and report the results. The Bureau of Mines is to make the necessary contracts with owners, lessees, and drillers, and is to direct the drilling operations. The areas thus far recommended for testing are in Texas and in New Mexico.

Just how important it is that we should make ourselves independent of foreign supplies of this indispensable plant food can be better understood when it is known that potassium salts to the value of more than $17,000,000 were imported to the United States in 1925. Most of the supply came from France and Germany.



The Kenora Paper Mills, Ltd., is planning to construct a railway line, 100 miles long, to connect the newly opened mining field of Red Lake with the Canadian Pacific and Canadian National Railways.

Roadbuilding in Germany is very expensive, as 75 per cent. of the work is still done by hand.

New Zealand imports annually for each inhabitant $175 worth of commodities, thus making her one of the biggest per capita importing countries in the world.

To determine suitable areas for the location of new oyster beds in Long Island Sound, the United States Bureau of Fisheries released 500 floating bottles from points along the Connecticut shore. By observing the courses of their drift and charting them, a record was obtained of the prevailing ocean currents. Two hundred of the bottles were recovered, revealing that the general direction of the currents in the region is eastward and shoreward. The information will enable oyster culturists to place their shells properly to receive the larval oysters drifting from the spawning beds.

For use in connection with their greasing and oiling pit, the Citizens Oil & Gas Company, of Canton, Ohio, has installed air equipment for blowing out crank cases before pouring in new oil. Air at a pressure of 200 pounds is used for the purpose.

The construction of what is said to be the largest gas project in the United States has been begun in Southern California by the Ventura Fuel Company. A 15-inch high-pressure pipe line, 75 miles in length, is to be built to carry natural gas from the Ventura field to Los Angeles.

In plants where pneumatic hoists are used trouble is sometimes experienced with cables pulling out. A good way to prevent this, we read in *Southern Power Journal*, is to get a hollow-ended retaining socket, slip the cable through it, and then fray the end of the cable. Next, pour enough Babbit metal or solder into the cavity to fill it. This assures a hold that is almost impossible to pull out.

From studies made by H. Morton Bodfish, of the Ohio State University, the average life of a business building in a rapidly growing city is 34.5 years.

By the building of a 23-mile line, Albania is renouncing its distinction of being the only country in Europe without a mile of railroad.

Mycalex is the name applied to a new insulating material developed by the General Electric Company at Schenectady, N. Y. It is made from ground mica and lead borate, and is designed for use in places where high frequencies are encountered, such as in radio broadcasting. Upon heating, mycalex softens to a plastic mass, allowing it to be molded into any desired forms. During the molding process, metal parts can be combined with the insulator. It is reported that the material possesses insulating properties that, in some respects, are superior to those of porcelain.

Yugoslavia has rich and extensive ore deposits which have remained undeveloped mainly because a lack of transport and means of communication. The iron-ore deposits in Bosnia are among the largest and most valuable in Europe.

The latest statistics reveal that more new railroad tracks were laid in 1926 than in any year since 1916. In the past twelvemonth, 1,005 miles were run, or 361 miles more than in 1925. Texas led all the states with new lines totaling 242 miles; Florida was second with 233 miles; and Arizona came third with 145 miles.

The first steam turbine in the United States was installed in 1895 in New York City. Just how great has been the advance in the intervening years in these electric generators can be appreciated when it is understood that efficient plants now require less than 2 pounds of coal to produce a kilowatt-hour of electricity as against 12 pounds 30 years ago.

According to the Economics Committee of the American Railway Association, the average cost of a freight-train-delay hour is about $24. The cost of starting and stopping trains of different tonnages and moving at various speeds varies from 70 cents to $2 for coal alone.

Work on what will be the largest power-generating station south of the Equator is now underway at Buenos Aires, Argentina. As designed, the plant is ultimately to be equipped with 12 turbines of 75,000 H. P. each, giving a total capacity of 900,000 H. P.